



SEPARATOR



54-00068



HAZ WASTE



COMPLIANCE



06/28/1996



NA

**FACILITY INVESTIGATION  
CEDAR CHEMICAL CORPORATION**

**VOLUME I**

**Prepared for:**

**Cedar Chemical Corporation  
West Helena, Arkansas**

**Prepared by:**

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**June 28, 1996**



## Table of Contents

1.0	INTRODUCTION .....	1-1
2.0	FACILITY BACKGROUND .....	2-1
2.1	Site Description .....	2-1
2.2	Site History .....	2-4
2.2.1	Present Site Operations .....	2-5
2.2.2	Solid and Hazardous Waste .....	2-5
2.3	Environmental Setting .....	2-8
2.3.1	Physiography .....	2-8
2.3.2	Regional Geohydrology .....	2-8
2.3.3	Site Geology .....	2-11
2.3.4	Geophysical Logging .....	2-13
2.3.5	Lithologic Description .....	2-15
2.3.6	Soil Classification .....	2-18
2.3.7	Site Hydrogeology .....	2-19
2.3.8	Meteorology and Air Quality .....	2-20
2.4	1995 Residential and Agricultural Well Survey .....	2-20
2.4.1	Residential Wells .....	2-22
2.4.2	Agricultural Wells .....	2-22
3.0	SAMPLING PROCEDURES .....	3-1
3.1	Soil Sampling .....	3-1
3.1.1	Hand-Augur Borings .....	3-1
3.1.2	Drill Rig .....	3-2
3.1.3	Geoprobe Soil Sampling .....	3-4
3.2	Monitoring Well Installation .....	3-5
3.2.1	Type II Well Installation .....	3-5
3.2.2	Shallow Type III Monitoring Well Installation .....	3-6
3.2.3	Intermediate Depth Groundwater Screening .....	3-8
3.2.4	Deep Type III Monitoring Well Installation .....	3-9
3.2.5	Monitoring Well Completion .....	3-12
3.3	Monitoring Well Development .....	3-13
3.4	Groundwater Sampling .....	3-13
3.5	Decontamination Procedure .....	3-14
3.6	Investigation Derived Waste (IDW) .....	3-15
3.7	Sample Nomenclature .....	3-16
4.0	SAMPLING PLAN .....	4-1
4.1	Background Soil Sampling .....	4-1
4.2	Site 1 Sampling (SWMUs 63, 64, 65, and 68) .....	4-1
4.2.1	Site 1 — Phase I Soil .....	4-3
4.2.2	Site 1 — Phase II Soil .....	4-3



4.2.3	Site 1 — Phase I Groundwater	4-4
4.2.4	Site 1 — Phase II Groundwater	4-4
4.3	Site 2 Sampling (SWMUs 69, 70, and 71)	4-5
4.3.1	Site 2 — Phase I Soil	4-6
4.3.2	Site 2 — Phase II Soil	4-8
4.3.3	Site 2 — Phase III Soil	4-8
4.3.4	Site 2 — Phase I Groundwater	4-9
4.3.5	Site 2 — Phase II Groundwater	4-10
4.4	Site 3	4-10
4.4.1	Site 3 — Phase I Soil	4-12
4.4.2	Site 3 — Phase II Soil	4-12
4.4.3	Site 3 — Phase III Soil	4-13
4.5	Site 4 (SWMUs 3 and 74)	4-13
4.5.1	Site 4 — Phase I Soil	4-13
4.5.2	Site 4 — Phase II Soil	4-15
4.5.3	Site 4 — Phase I Groundwater	4-16
4.5.4	Site 4 — Phase II Groundwater	4-17
4.6	Site 5	4-17
4.7	Site 6	4-18
4.7.1	Site 6 — Phase I Soil	4-22
4.7.2	Site 6 — Phase II Soil	4-22
4.8	Site 8 (Area of Concern 3)	4-22
4.8.1	Site 8 — Phase I Soil Sampling	4-23
4.9	Site 9	4-23
4.9.1	Site 9 — Phase I Soil	4-23
4.9.2	Site 9 — Phase II Soil	4-26
4.9.3	Site 9 — Phase II Groundwater	4-26
4.10	Dichloroethane Source Area Investigation	4-27
4.11	Offsite Groundwater Plume Delineation	4-29
4.11.1	Offsite Groundwater Screening	4-29
4.11.2	Offsite Monitoring Wells	4-30
4.12	Baseline Groundwater Sampling Event	4-32
5.0	SOIL CONTAMINATION	5-1
5.1	Background Soil Samples	5-1
5.2	Site 1 Soil Contamination	5-1
5.3	Site 2 Soil Contamination	5-8
5.4	Site 3 Soil Contamination	5-27
5.5	Site 4 Soil Contamination	5-33
5.6	Site 5 Soil Contamination	5-42
5.7	Site 6 Soil Contamination	5-42
5.8	Site 8 Soil Contamination	5-51
5.9	Site 9 Soil Contamination	5-51
5.10	Source Area Investigation Results	5-67
5.11	Air Monitoring	5-67



6.0	GROUNDWATER ASSESSMENT	6-1
6.1	Site-Specific Hydrogeologic Setting	6-1
6.1.1	Perched Zone	6-1
6.1.2	Alluvial Aquifer	6-2
6.1.3	Potentiometric Surface Data	6-2
6.2	Analytical Characterization	6-10
6.2.1	Phase I Data	6-10
6.2.2	Phase II Analytical Data	6-24
6.2.3	Phase III Data	6-39
6.2.4	Baseline Groundwater Sampling Event Results	6-48
6.3	Preliminary Hydrogeological Assessment	6-49
6.3.1	Slug Test Data	6-49
6.3.2	Regional Aquifer Characterization	6-58
6.3.3	Groundwater Velocity	6-59
7.0	CONCLUSIONS	7-1
7.1	Soil	7-1
7.1.1	Site 1 — Wastewater Treatment Ponds	7-1
7.1.2	Site 2 — Former Waste Treatment Ponds	7-1
7.1.3	Site 3 — Storm Water Ditches	7-2
7.1.4	Site 4 — Rail Spur Loading/Unloading Area	7-3
7.1.5	Site 5 — Maintenance Services Drum Vault	7-3
7.1.6	Site 6 — Area of Concern 1	7-3
7.1.7	Site 9 — Former Dinoseb Disposal Ponds	7-4
7.1.8	1,2-Dichloroethane Source Area	7-4
7.2	Groundwater	7-5

### List of Figures

Figure 2-1	Vicinity Map	2-2
Figure 2-2	Site Map	2-3
Figure 2-3	Surface of Semiconfining Unit	2-14
Figure 2-4	Residential and Agricultural Well Locations	2-21
Figure 3-1	Type II Well Schematic	3-6
Figure 3-2	Type III Well Schematic	3-7
Figure 4-1	Site 1 Sampling Locations	4-2
Figure 4-2	Site 2 Sampling Locations	4-7
Figure 4-3	Site 3 Sample Location Map	4-11
Figure 4-4	Site 4 Sampling Locations	4-14
Figure 4-5	Site 5 Sampling Locations	4-19
Figure 4-6	Slant Boring Schematic	4-20
Figure 4-7	Site 6 Sampling Locations	4-21
Figure 4-9	Site 9 Sampling Locations and Well	4-25
Figure 4-10	Source Area Sampling Grid and 1,2-Dichloroethane Concentrations	4-28



Figure 4-11	Offsite Groundwater Sampling Locations and Offsite Well Locations . . .	4-31
Figure 5-1	Total Pesticides in Soil (0-5 feet) . . . . .	5-7
Figure 5-2	Site 2 Methylene Chloride Concentrations in Soil . . . . .	5-17
Figure 5-3	Site 2 1,2-Dichloroethane Concentrations in Soil . . . . .	5-18
Figure 5-4	Site 2 Total VOCs in Soil (0 to 25 feet) . . . . .	5-19
Figure 5-5	Total VOCs in Soil (25 to 35 feet) . . . . .	5-20
Figure 5-6	Total SVOCs in Soil (0 to 25 feet) . . . . .	5-21
Figure 5-7	Total SVOCs in Soil (25 to 30 feet) . . . . .	5-22
Figure 5-8	Total Pesticides in Soil (0 to 25 feet) . . . . .	5-23
Figure 5-9	Total Pesticides (25 to 30 feet) . . . . .	5-24
Figure 5-10	Site 4 Dinoseb Concentrations in Soil (0 to 2 feet) . . . . .	5-40
Figure 5-11	Site 4 Dinoseb Concentrations in Soil (7 to 12 feet) . . . . .	5-41
Figure 5-12	Phase II Site 6 Total VOCs in Soil (0-5 feet) . . . . .	5-56
Figure 5-13	Phase II Site 6 Total VOCs in Soil (5-10 feet) . . . . .	5-57
Figure 5-14	Phase II Site 6 Total SVOCs in Soil (0-1 feet) . . . . .	5-58
Figure 5-15	Phase II Site 6 Total SVOCs in Soil (0-5 feet) . . . . .	5-59
Figure 5-16	Phase II Site 6 Total SVOCs in Soil (5-10 feet) . . . . .	5-60
Figure 5-17	Phase II Site 6 Total Pesticides in Soil (0-1 feet) . . . . .	5-61
Figure 5-18	Phase II Site 6 Total Pesticides in Soil (0-5 feet) . . . . .	5-62
Figure 5-19	Phase II Site 6 Total Pesticides in Soil (5-10 feet) . . . . .	5-63
Figure 5-20	Site 9 Dinoseb Concentrations in Soil 0- 5-Foot Interval . . . . .	5-64
Figure 5-21	Site 9 Dinoseb Concentrations in Soil 5- 10-Foot Interval . . . . .	5-65
Figure 5-22	Site 9 Dinoseb Concentrations in Soil 10- 15-Foot Interval . . . . .	5-66
Figure 5-23	Source Area Sampling Grid and 1,2-Dichloroethane Concentrations . . .	5-76
Figure 6-1	Phase I Alluvial Potentiometric Surface Map . . . . .	6-3
Figure 6-2	Phase II Alluvial Potentiometric Surface Map — November 1994 . . . .	6-4
Figure 6-3	Phase II Alluvial Potentiometric Surface Map — January 1995 . . . . .	6-5
Figure 6-4	Potentiometric Surface Map April 1, 1996 . . . . .	6-9
Figure 6-5	Phase II Potentiometric Surface in the Perched Zone . . . . .	6-17
Figure 6-6	Phase I 1,2-Dichloroethane Concentrations in the Alluvial Aquifer . . . .	6-19
Figure 6-7	Phase I 1,2-Dichloroethane Plume in the Perched Zone . . . . .	6-20
Figure 6-8	Phase I Dinoseb Plume in the Alluvial Aquifer . . . . .	6-22
Figure 6-9	Phase I Miscellaneous Organic Compounds in the Alluvial Aquifer . . . .	6-23
Figure 6-10	Phase II 1,2-Dichloroethane Plume in the Alluvial Aquifer . . . . .	6-35
Figure 6-11	Phase II 1,2-dichloroethane in the Perched Zone . . . . .	6-37
Figure 6-12	Phase II Dinoseb Plume in the Alluvial Aquifer . . . . .	6-38
Figure 6-13	Phase II Miscellaneous Organic Compounds in the Alluvial Aquifer . . .	6-40
Figure 6-14	Phase II Total VOCs in the Alluvial Aquifer . . . . .	6-41
Figure 6-15	Phase II Total SVOCs in the Alluvial Aquifer . . . . .	6-42
Figure 6-16	Phase II Total VOCs in the Perched Zone . . . . .	6-43
Figure 6-17	Phase II Total SVOCs in the Perched Zone . . . . .	6-44
Figure 6-18	Phase III Lateral Extent of 1,2-Dichloroethane . . . . .	6-52
Figure 6-19	Phase III Vertical Extent of 1,2-Dichloroethane . . . . .	6-53



## List of Tables

Table 2-1	Generalized Stratigraphic Column of the Gulf Coastal Plain in Arkansas (Cenozoic Era) . . . . .	2-10
Table 2-2	Residential Well Survey Results . . . . .	2-23
Table 2-3	Agricultural Well Survey Results . . . . .	2-24
Table 5-1	Phase I Background Soil Samples . . . . .	5-2
Table 5-2	Phase I Site 1 Soil Data . . . . .	5-3
Table 5-3	Phase II Site 1 Soil Data . . . . .	5-9
Table 5-4	Phase I Site 2 Soil Data . . . . .	5-10
Table 5-5	Phase II Site 2 Soil Data . . . . .	5-26
Table 5-6	Phase III Site 2 Soil Data . . . . .	5-28
Table 5-7	Phase I Site 3 Sediment Data . . . . .	5-29
Table 5-8	Phase II Site 3 Sediment Data . . . . .	5-31
Table 5-9	Phase III Site 3 Soil Data . . . . .	5-32
Table 5-10	Phase I Site 4 Soil Data . . . . .	5-34
Table 5-11	Phase II Site 4 Soil Data . . . . .	5-39
Table 5-12	Phase I Site 5 Soil Data . . . . .	5-43
Table 5-13	Phase I Site 6 Soil Data . . . . .	5-44
Table 5-14	Phase I Interim Measure Data . . . . .	5-48
Table 5-15	Phase II Site 6 Soil Data . . . . .	5-52
Table 5-16	Phase I Site 8 Soil Data . . . . .	5-53
Table 5-17	Phase I Site 9 Soil Data — SVOCs . . . . .	5-54
Table 5-18	Phase I Site 9 Soil Data — Full Scan Analysis . . . . .	5-55
Table 5-19	Phase II Site 9 Soil Data . . . . .	5-68
Table 5-20	Field Screening Results for 1,2-Dichloroethane in Soil . . . . .	5-69
Table 5-21	Source Area Investigation Contract Laboratory Split Soil Samples Volatile Organic Compounds . . . . .	5-71
Table 5-22	Source Area Investigation Contract Laboratory Split Soil Samples Semivolatile Organic Compounds . . . . .	5-72
Table 5-23	Source Area Investigation Contract Laboratory Split Soil Samples Chlorinated Pesticides . . . . .	5-73
Table 5-24	Air Monitoring Results . . . . .	5-74
Table 6-1	Potentiometric Surface Elevations (ft msl) . . . . .	6-7
Table 6-2	Phase I Facility Investigation, Groundwater Data . . . . .	6-11
Table 6-3	Phase II Facility Investigation, Groundwater Data . . . . .	6-25
Table 6-4	Offsite Groundwater Results for 1,2-Dichloroethane (ppb) . . . . .	6-46
Table 6-5	Baseline Groundwater Sampling Event, Full Scan Results (ppb) . . . . .	6-50
Table 6-6	Slug Test Solution Assumptions . . . . .	6-55
Table 6-7	Phase II Slug Test Data . . . . .	6-57

## **List of Appendices**

- Appendix A Boring Logs
- Appendix B Physical Properties Results
- Appendix C Geophysical Logs
- Appendix D Analytical Report
- Appendix E Site Wide Map of All Site Sampling Location



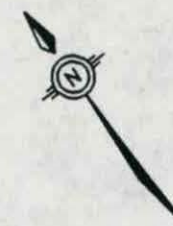
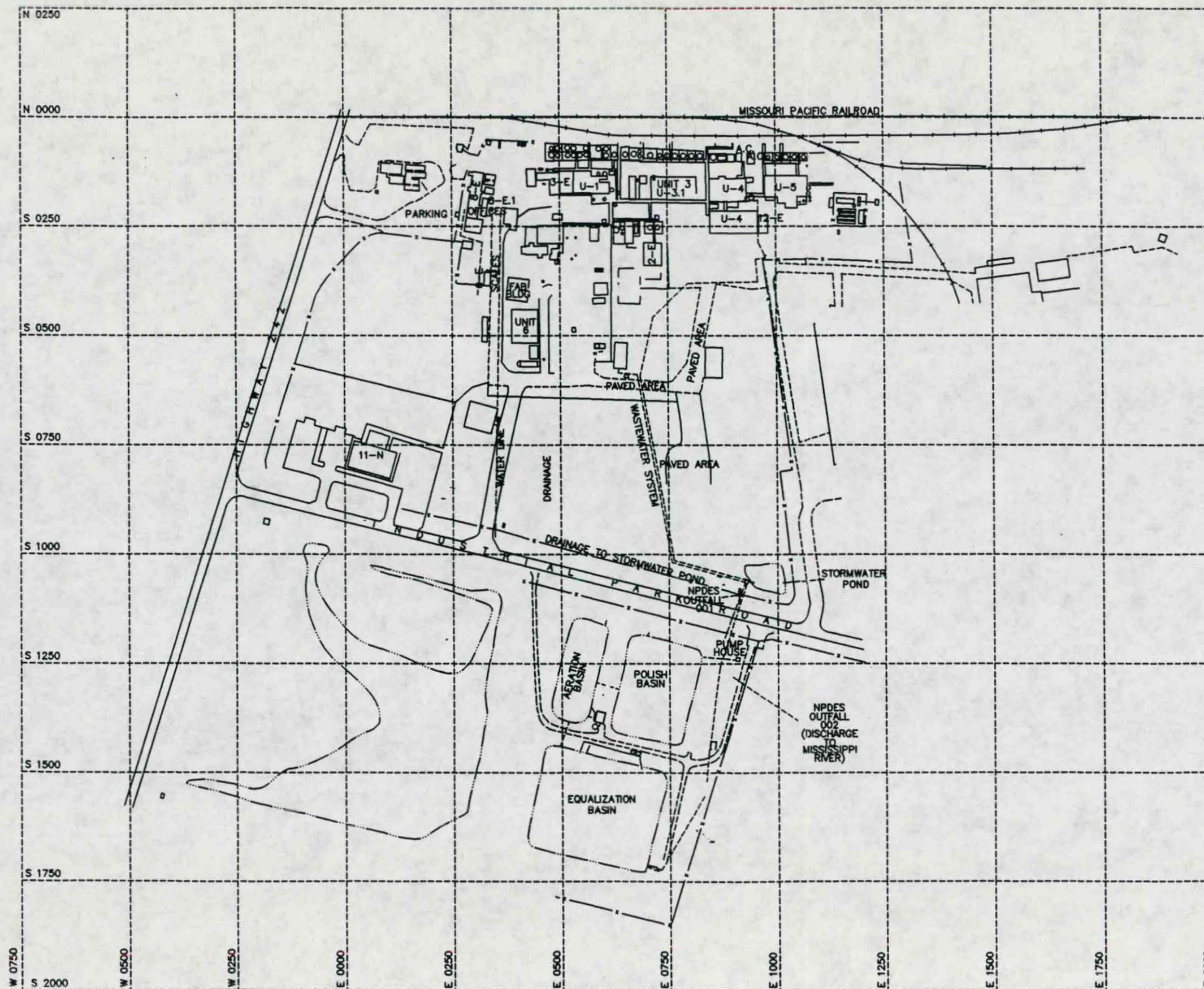


## **1.0 INTRODUCTION**

This Facility Investigation (FI) Report has been completed by Environmental and Safety Designs, Inc. (EnSafe), of Memphis, Tennessee, on behalf of Cedar Chemical Corporation.

Cedar Chemical Corporation agreed to conduct the FI pursuant to the Consent Administrative Order (CAO) No. LIS 91-118, issued by the Arkansas Department of Pollution Control and Ecology (ADPC&E) for the Cedar Chemical facility in West Helena, Arkansas. Fieldwork for Phase I of the FI began on August 30, 1993. Upon completion of Phase I, a Technical Memorandum submitted to ADPC&E summarized the investigation's findings. Based on the results of the field sampling and analysis, Phase II of the FI was recommended to fill data gaps and further delineate contamination identified in the first phase. Following ADPC&E's approval of the submitted work plan, Phase II began on November 7, 1994. Upon completion of Phase II, a Facility Investigation Report was submitted to ADPC&E for review and comment. Per ADPC&E comments, in order to finalize the FI report, Cedar Chemical was required to characterize and delineate the source of 1,2-dichloroethane in soil, and delineate the vertical and areal extent of 1,2-dichloroethane in groundwater. The Interim Response Work Plan (Phase III), addressing these issues, was submitted for approval on April 10, 1995. Field work for Phase III began on September 19, 1995. This report documents Phases I, II and III of the FI.





- LEGEND
- WATER OR DRAINAGE
  - ROAD
  - TRAIL
  - SIDEWALK
  - RAILROAD
  - BUILDING
  - FENCE
  - SUBSURFACE PIPING (APPROX.)

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

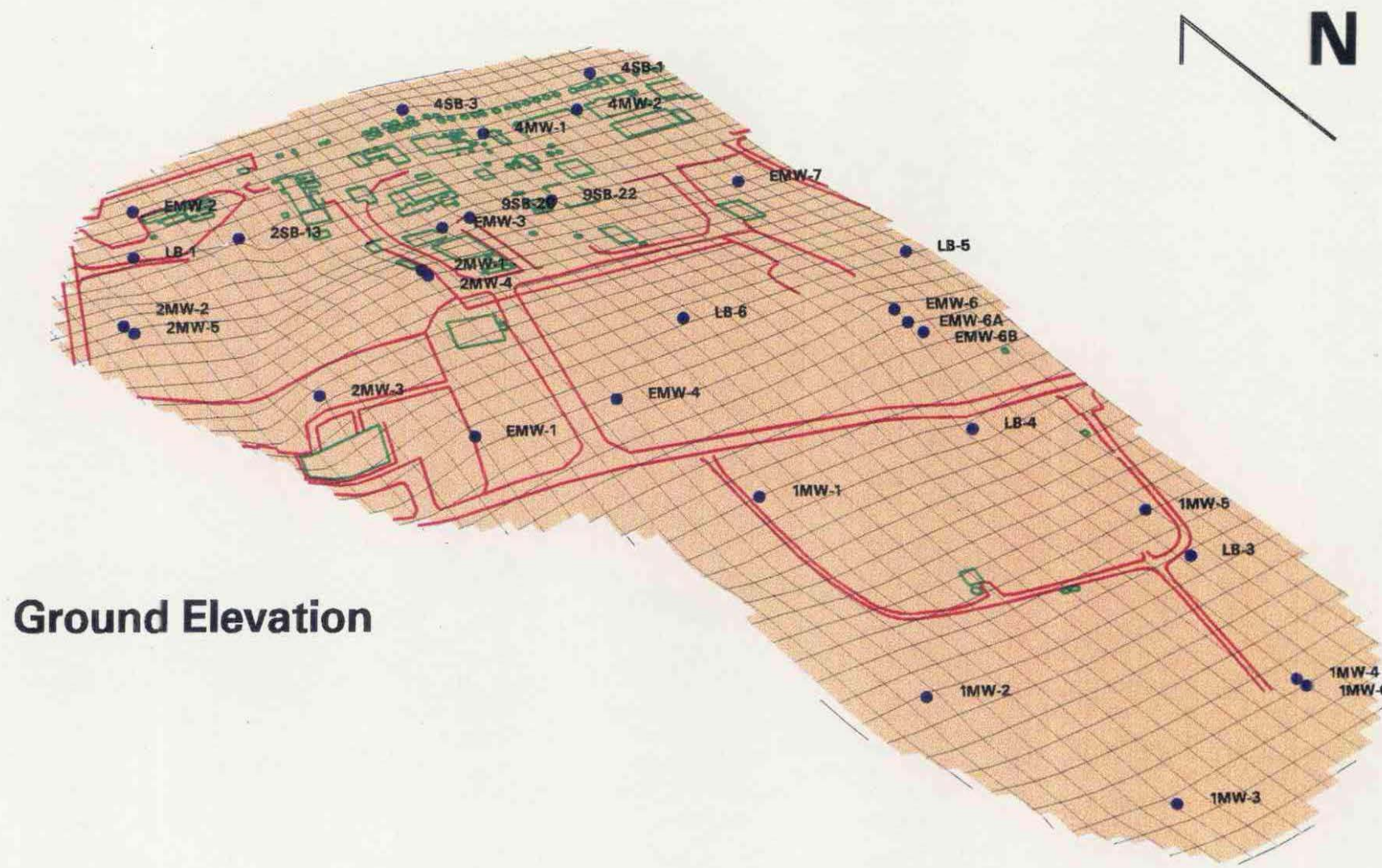
**EN SAFE**

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NASHVILLE, TN, PENSACOLA, FL., AND RALEIGH, NC.

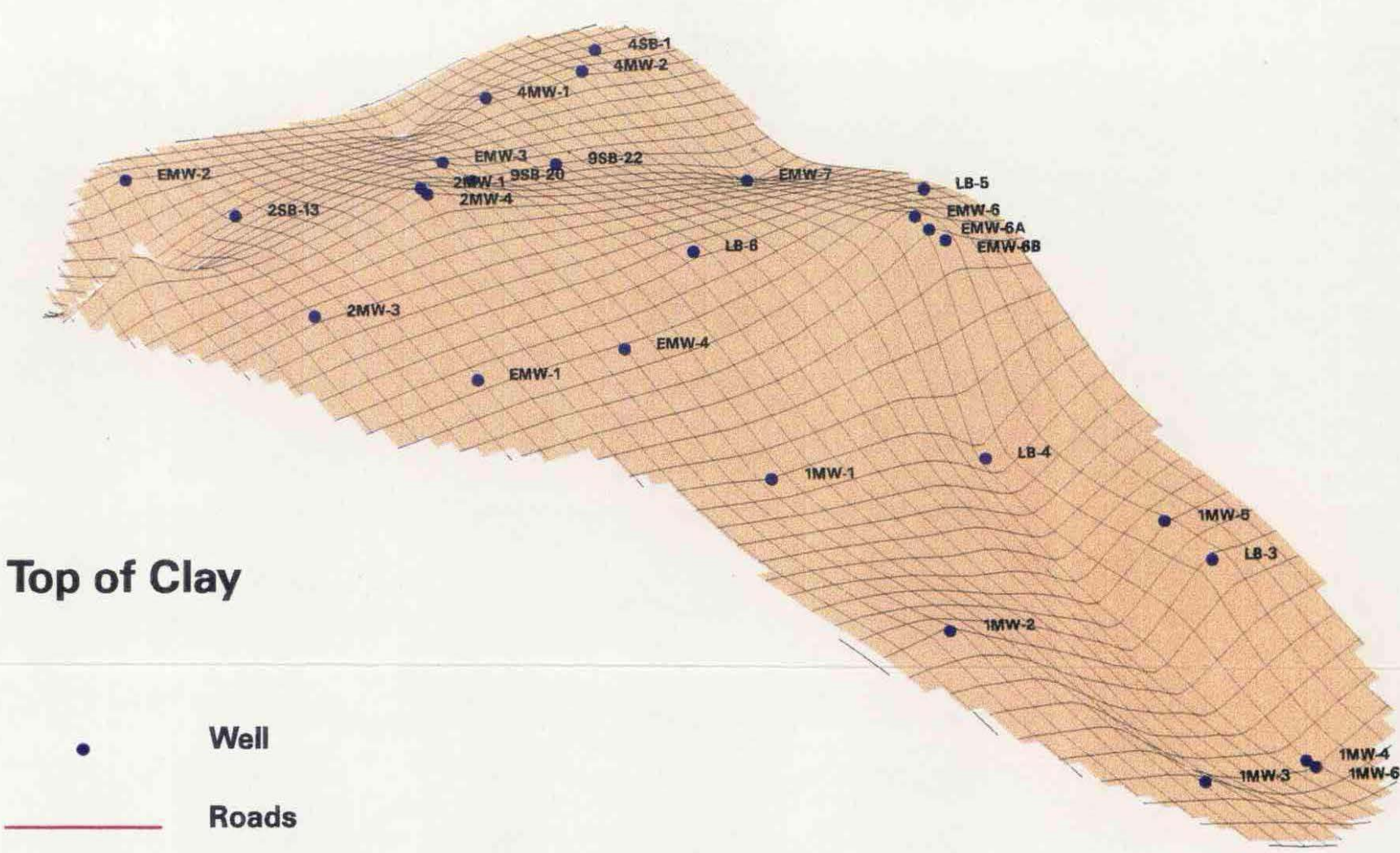
FIGURE 2-2  
SITE MAP  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 03/01/95 DWG NAME: CEDAR85





**Ground Elevation**



**Top of Clay**

- Well
- Roads
- Buildings

Surface Exaggeration: 20

Environmental and Safety Designs, Inc.



5724 SUMMER TREES DR. MEMPHIS, TN, 38134 \*(901)372-7962  
NASHVILLE, TN., PENSACOLA, FL., AND RALEIGH, NC.

**Figure 2-3**  
**Top of Surficial Clay Surface**  
**Cedar Chemical**  
**Facility Investigation Report**



## **2.0 FACILITY BACKGROUND**

The following section provides background information on the Cedar Chemical facility, including description's of the site's location, geology, and surrounding areas. A general history of the site is also included.

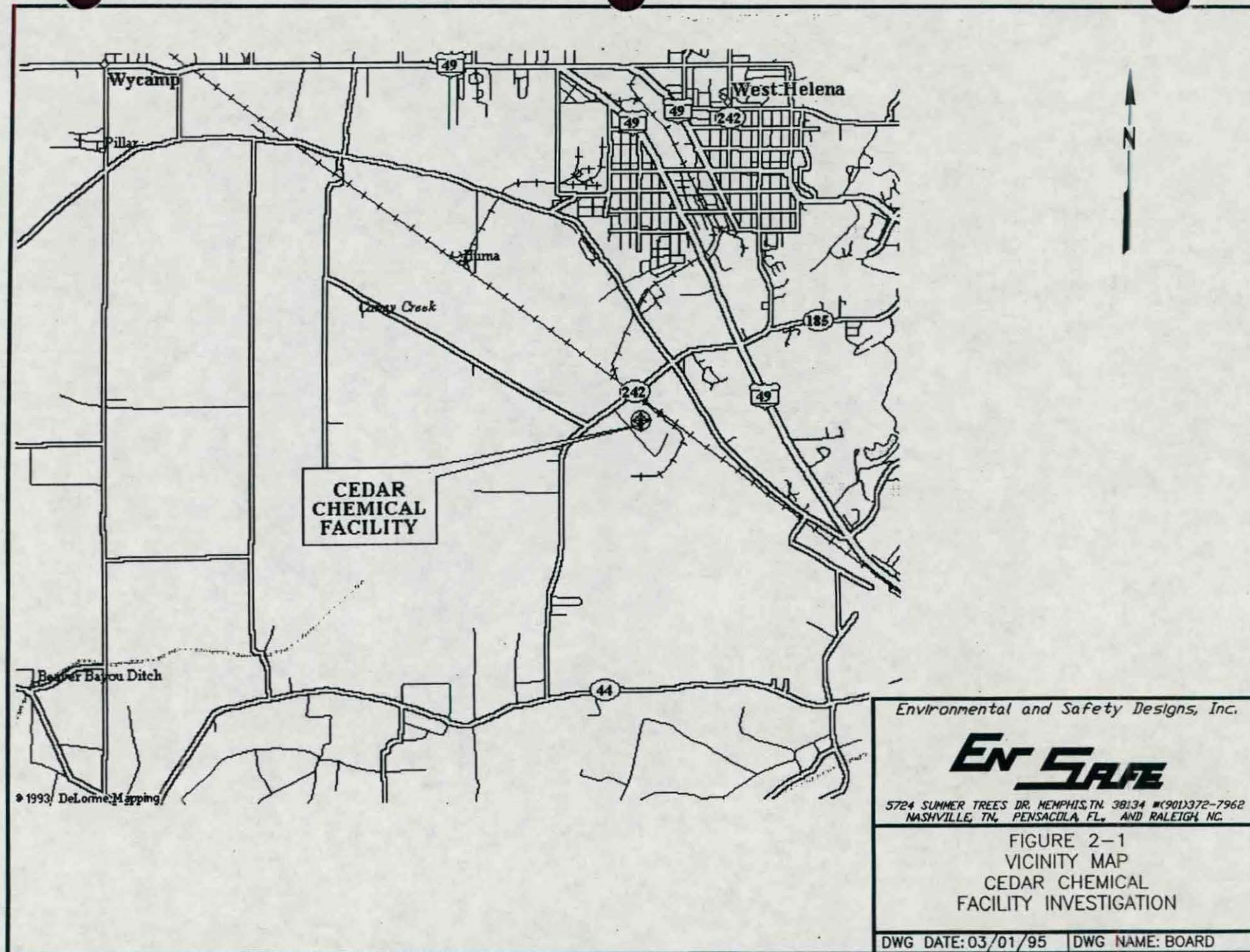
### **2.1 Site Description**

Cedar Chemical Corporation owns and operates the subject chemical manufacturing facility in Phillips County, Arkansas, just south of West Helena, Arkansas. The site consists of approximately 48 acres along State Highway 242, one mile southwest of the intersection of U.S. Highway 49 and Highway 242. A map of the area surrounding the facility is included in Figure 2-1. Figure 2-2 is a facility site plan.

The facility consists of five production units and support facilities, an office on the north side of Industrial Park Road, and a biological treatment system south of the road. The entire Cedar facility is fenced with controlled access. Active processes are conducted on approximately 20 acres. The rest of the site contains the biological treatment ponds and closed surface impoundments, or is unoccupied.

The site is in the Helena-West Helena Industrial Park. It is bounded by Arkansas Highway 242 to the northwest, a Union-Pacific railway to the northeast, and other industrial park properties to the southeast and southwest. The land across Highway 242 is agricultural. Residential areas are located within one half mile southwest and northeast of the site. Several domestic wells and irrigation wells were within a one-mile radius of the site; however, all of the domestic wells identified in a door-to-door survey were no longer used. Grubbs, Garner & Hoskyn, Inc. (GG&H), of Little Rock, Arkansas, conducted a well survey in 1988. Plate 19 of the GG&H report (July 19, 1988) presents the locations of the irrigation wells in the West Helena vicinity. EnSafe's 1995 well survey is discussed in Section 2.4.







The Cedar Chemical plant receives water from two potable water supplies. The front offices, shower room, and laboratory receive potable water from the City of West Helena. The City of Helena supplies the rest of the plant.

Much of the nonhazardous process and sanitary wastewater discharges to a three-pond biologic treatment system on the west side of the plant across Industrial Park Road. Effluent from the treatment system is pumped offsite through a 4.5-mile pipeline which discharges directly into the Mississippi River through National Pollutant Discharge Elimination System (NPDES) permitted outfall No. 002. Storm water runoff across the site is channeled through a series of ditches which drains to the southwest corner of the site, where it is pumped under industrial park road to the treatment ponds. No other waste is treated or disposed onsite.

## **2.2 Site History**

Prior to 1970, the Cedar Chemical plant site was cultivated farmland. In 1970, Helena Chemical Company acquired the site to construct a Propanil manufacturing facility. In 1971, the newly constructed plant was sold to J.A. Williams, who in turn transferred the plant to Eagle River Chemical Corporation, a newly formed Arkansas corporation which was initially controlled by the Ansul Company. Under Ansul's management, the plant was converted to the production of dinitrobutylphenol, also known as dinoseb. In late 1972, Ansul sold its majority stock interest in Eagle River Chemical Corporation back to the corporation, leaving J.A. Williams as the sole shareholder. Eagle River Chemical Corporation was subsequently merged into Vertac Chemical Corporation. Vertac operated the plant until Cedar Chemical Corporation acquired the site in 1986.

Solid wastes generated during the period prior to Vertac's operation are largely unknown. It should be noted that formulation processes vary because of the contract nature of the agricultural chemical business. However, the manufacturing segment is routine and not subject to substantial variation.



### **2.2.1 Present Site Operations**

Cedar Chemical manufactures various agricultural chemicals and organics including insecticides, herbicides, polymers, and organic intermediates. Plant processes are batch operations with seasonal production fluctuations and constant product introductions. Cedar Chemical manufactures its own products (such as Propanil, a rice herbicide) and also custom manufactures chemicals for contract clients. Formulation and packaging are ancillary activities, and are conducted only when the product is ready for the consumer market.

The facility employs approximately 125 people. The plant operates 24 hours a day, seven days a week.

Unit 1 formulates various custom agricultural products for other companies. Unit 2 is the Propanil production unit. Unit 3 was destroyed in a fire and explosion on September 26, 1989. Unit 4 produces various custom products. Unit 5 primarily manufactures nitroparaffin derivatives. In 1991, Unit 6 began producing dichloroaniline, which is used in the production of Propanil.

### **2.2.2 Solid and Hazardous Waste**

Cedar Chemical is a large-quantity generator of hazardous wastes. Most of these wastes are classified as hazardous through process knowledge; therefore, no data from analysis of the waste are available.

Although most of the hazardous waste generated at the facility is transported offsite for disposal, some basic treatment processes do occur onsite regarding characteristic wastes. Waste propionic acid and waste sodium hypochlorite scrubber liquor treated in enclosed treatment vessels within process units at the site are exempt from hazardous waste permitting. Waste propionic acid undergoes elementary neutralization through the addition of anhydrous ammonia. Waste sodium hypochlorite is treated with sodium sulfite to remove excess hypochlorite. After treatment, these



materials, which no longer exhibit the corrosivity characteristic of a hazardous waste, are discharged to the biological treatment ponds.

The remaining hazardous wastes generated are shipped offsite for disposal. Cedar Chemical does not currently conduct onsite storage or disposal activities for the hazardous wastes generated there. Except for the wastes described in the previous paragraph, hazardous wastes generated at the facility are stored onsite less than 90 days and transported offsite for disposal at an approved landfill, incinerator, or deep-well injection facility. Any airborne constituents emitted from the plant in its current mode of operation are provided for under Permit 878-AR-9 issued on October 3, 1994, by the ADPC&E.

The plant filed a Part A hazardous waste management facility permit application with the ADPC&E in November 1980. Interim status was granted for a hazardous waste storage tank, a hazardous waste container storage area, and a hazardous waste treatment unit (the biological treatment system). A Part B application was filed on August 15, 1984. The Part B application was accepted through the notice of deficiency (NOD) process as technically complete. However, the two storage units were closed in accordance with Resource Conservation Recovery Act (RCRA) regulations in 1988. No post closure care is required. A thorough review by ADPC&E concluded that hazardous waste was not being treated at the biological treatment system. Therefore, ADPC&E never processed the Part B application.

Certain nonhazardous wastestreams, which are evaluated individually, are sent to offsite disposal facilities because of their incompatibility with the biological treatment system. An example of this is a wastestream with a high salt concentration.

Onsite waste disposal methods were used at the facility before Cedar Chemical acquired it. It is known that during certain periods between 1971 and 1973, the former owners began disposing of wastewaters in three unlined earthen ponds. Thereafter, Helena Chemical Company (at the



time an affiliate of the site owner) used the ponds to dispose of wastewater generated in its formulating and packaging operations at a nearby Helena Chemical facility where agricultural chemicals were also produced.

During the previous period of onsite disposal, the three ponds are believed to have received propionic acid wastes, a calcium chloride brine stream from an insecticide process, and a sulfuric acid waste. The small pond was used to neutralize dichloroaniline, sulfuric acid, and propionic acid through limestone addition. The other two ponds were used for waste disposal. Wash waters from Helena Chemical's chemical formulation operations were also directed into the ponds. Helena Chemical formulated some 100 to 200 compounds, and has no knowledge of what types of wastes were disposed in the ponds. Helena Chemical stopped disposing of its wastes in the ponds in early 1976. The ponds were closed in 1978. The closure procedure consisted of pumping the water from the ponds and then placing a clay cap of native soil and bentonite over them. The water was removed and disposed of by Rollins Environmental Services.

Before Cedar Chemical purchased the property, as many as 300 drums of waste were placed in a concrete vault beneath the onsite warehouse. The current condition and contents of these drums are unknown. While constructing a drainage ditch, buried drums were found near the newest production unit (Unit 6). Cedar Chemical has removed these buried drums in accordance with the approved removal work plan dated June 1990.

Since the current CAO was issued, Cedar Chemical officials obtained information from individuals who worked at the plant prior to Cedar's purchase concerning the existence and location of two additional drum burial sites. A geophysical survey was conducted at the site and subsurface anomalies were identified in the areas where drums were suspected to have been buried. Immediate removal actions were conducted by Cedar Chemical for the additional buried drums.



## **2.3 Environmental Setting**

The following section provides details concerning the site's physiographic setting and the nature of its underlying geohydrologic framework. The discussion summarizes geologic and hydrologic data collected and analyzed during Phases I and II of the FI.

### **2.3.1 Physiography**

The Cedar Chemical facility is approximately two miles west of the Mississippi River in part of a physiographic province and setting known as the Mississippi Embayment Region of the Gulf Coastal Plain. The topography of the terrain at the site and surrounding area is relatively flat with some areas dipping gently toward the southeast. Ground surface elevations at the site tend to vary from about 188 feet mean sea level (msl) in the southwest to 200 feet msl in the northeast. Localized changes in topographic relief are due mainly to alterations for construction or for directing surface flow runoff. Generally, surface flow runoff tends to be toward the southeast and the Mississippi River. Since topography is relatively flat, overland flow velocities are low and some areas where the original ground surface has not been modified are poorly drained. To improve drainage, a series of unlined storm water drainage ditches have been constructed to divert runoff water to retention and treatment basins. The facility is not in the 100-year floodplain of the Mississippi River.

### **2.3.2 Regional Geohydrology**

The following discussion presents information concerning the regional geohydrology in the eastern Arkansas area. This includes a description of the major stratigraphic units and the occurrence and movement of groundwater within these units.

The lowermost geologic unit of concern at the site is the Sparta Sand of Tertiary age. The Sparta Sand consists mainly of a gray, very fine to medium sand with brown and gray sandy clay. This formation appears to consist of a beach complex deposited during a regressive phase of the ancient sea and ranges from 300 to 400 feet thick. The Sparta Sand serves as the major



deep source of potable groundwater in the Helena/West Helena area. Regional groundwater flow in the Sparta Sand is generally southeast toward the Mississippi River.

Overlying the Sparta Sand is the undifferentiated Jackson-Claiborne Group, also deposited during the Tertiary. The Claiborne Group consists mainly of silty clay with some thin, discontinuous beds of silty clay and lignite. The Jackson Group typically comprises gray, brown, and green silty clay with some peat and lignite. In this area, the Jackson Clay is approximately 250 feet thick.

The Jackson Group is overlain by alluvial deposits of Quaternary Age. These deposits are approximately 150 feet thick and consist of coarse sands and fine gravels at the base of the unit, fining upward to fine sand, silt, and clay at the surface. Portions of these upper soils apparently consist of outwash from Crowley Ridge as evidenced by the relatively high silt content.

These alluvial deposits provide groundwater for some irrigation wells in the areas surrounding Helena and West Helena, Arkansas. The irrigation wells are reportedly capable of producing approximately 1,000 gallons per minute (gpm). Groundwater flows generally toward the east to the Mississippi River.

An excerpt from a table illustrating the generalized stratigraphic column of the Gulf Coastal Plain in Arkansas — found in U.S. Geological Survey (USGS) Water Resources Investigations Report 85-4116 — is included as Table 2-1 in order to provide additional regional geologic information.



Table 2-1  
Generalized Stratigraphic Column of the Gulf Coastal Plain in Arkansas (Cenozoic Erathem)

System	Series	Group	Formation	Description	Water Supply
Quaternary	Holocene and Pleistocene		Alluvium and terrace deposits	Alluvial floodplain and terrace deposits; gravel at base, grading upward to sand, silt, and clay at the surface. Maximum thickness about 200 feet in the Mississippi Alluvial Plain.	Sand and gravel in the alluvial and terrace deposits compose extensive aquifers throughout most of Mississippi Alluvial Plain. Commonly yields 1,000 to 3,000 gallons per minute of water to wells.
Tertiary	Eocene	Jackson		Chiefly composed of clay, some lenses of fine sand. Maximum thickness about 300 feet. Confining bed.	Does not produce water to wells.
			Cockfield Formation	Fine lignitic sand and carbonaceous clay; maximum thickness less than 300 feet.	Mainly a source of domestic water supply. Locally yields up to 400 gallons per minute of water to wells.
		Claiborne	Cook Mountain Formation	Carbonaceous clay and some lenses of fine lignitic sand. Maximum thickness about 150 feet. Confining bed.	Does not produce water to wells.
			Sparta Sand      Memphis Sand	Fine to medium sand, some interbeds of clay. Maximum thickness nearly 900 feet. North of latitude 35 degrees, the Sparta Sand is part of the Memphis Sand.	Principal source of municipal and industrial water supply in its area of occurrence. In southcentral Arkansas, the Sparta Sand is a nearly sole-source aquifer for municipal and industrial water supplies. Commonly yields up to 1,000 gallons per minute of water to wells.



### **2.3.3 Site Geology**

The previous investigations conducted by GG&H, and the FI conducted by EnSafe have confirmed the following general stratigraphic succession beneath the site from surface to depth:

- Surface soils and loess of the fluvial alluvium
- Fluvial alluvium aquifer deposits, coarsening downward
- Jackson Clay Group
- Sparta Sand

The alluvial deposits were the primary target of the EnSafe investigation and most of the wells and borings were completed in the alluvium. As a result of this detailed FI, five separate stratigraphic units have been identified within the alluvial section beneath the site. Consequently, it should be clearly noted that any reference to multiple lithologic "units" in the following discussion of site geology pertains to the alluvial deposits only. The investigation involved only minimal sampling of the Jackson Clay surface, and no sampling of the Sparta Sand. The boring and well construction logs for all investigation borings and wells are provided in Appendix A.

#### **Jackson Clay**

The lowermost contact is at the boundary of the Jackson Clay and the alluvium. The Jackson Clay consists of a very stiff, dark gray, sandy clay with lignite (Jackson Clay surface). A split-spoon sample of this unit was collected at approximately 150 feet below ground surface (bgs) from the boring for well 4MW-4 during Phase II of the FI. The recovered sample consisted of peat and lignite. Based on this sample and the structure map of the Jackson Clay surface produced from data collected during the GG&H investigation, this stratum is approximately 150 feet bgs.



## **Alluvium**

The alluvial deposits discussed in the regional geology section were encountered above the Jackson Clay. During well and boring installation, three very distinct contacts were observed in the alluvial deposits. These observed contacts are: 1) between the Jackson Clay and the overlying alluvial sand and gravels, 2) between the alluvial sands and gravels and a silty clay semiconfining unit, and 3) between the semiconfining unit and the surficial silty clays and clayey silts. Geophysical logging conducted after the deep wells were installed detected two additional units within the alluvial sands and gravels.

A fining upward sand and gravel sequence is present from the surface of the Jackson Clay to approximately 135 feet bgs. The contact between the Jackson Clay and the sands and gravels is the first visibly distinct contact. Above 135 feet is a fining upward sand sequence, ranging from a poorly sorted coarse sand at 135 feet to a very fine silty sand at the top of the sequence at approximately 40 feet bgs. Lignite and other organic material are associated with the alluvial section. Additional subtle lithologic changes within the sands were observed during subsequent geophysical logging of the deep wells. Section 2.2.4 discusses the findings of the geophysical logging activities.

Five Shelby tube samples collected from the alluvial deposits during Phase I of the investigation were analyzed for Atterburg Limits, grain size analysis using the dual classification system in the Unified Soil Classification System, and permeability. Permeabilities of this sequence average  $10^{-5}$  centimeters per second (cm/sec). The samples were collected at various depths from soil borings installed at Sites 1, 2, 4, 6, and 9. The results of the physical properties analyses are presented in Appendix B.

Interbedded, very stiff to firm, tan, gray, and brown silty clay and clayey silts were encountered from the top of the alluvial sands to ground surface. Coefficients of permeability of this silty



clay unit were found to range from  $4.0 \times 10^{-5}$  cm/sec in the upper portion of the silts and clays, to  $8.5 \times 10^{-8}$  cm/sec in the lower portion of the silts and clays.

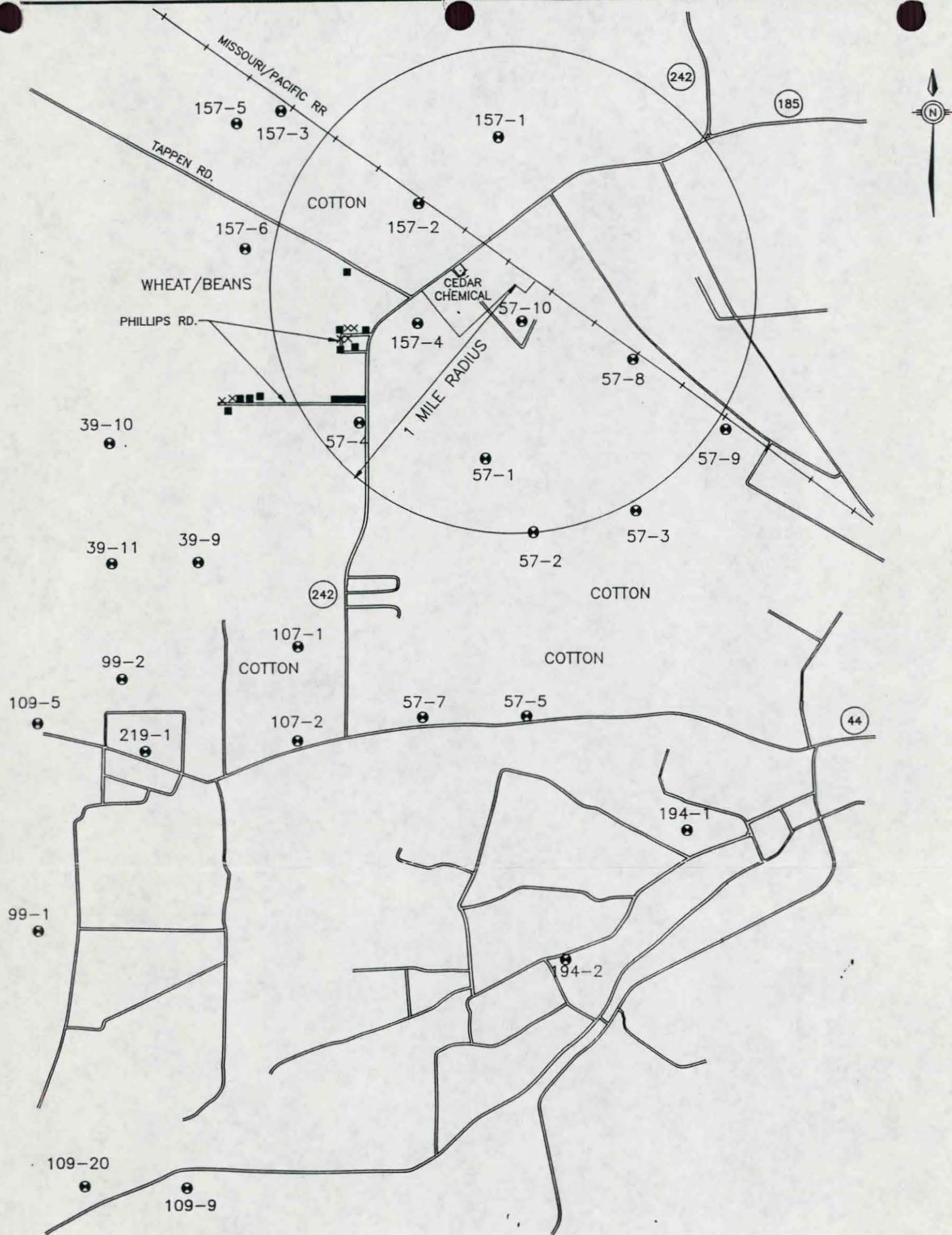
During the investigation, these silty clays and clayey silts have been addressed as two distinct lithologic units. The lower unit overlies the alluvial sands and gravels. This unit consists of a tight, gray to olive-gray clay with silt ranging from approximately 15 to 20 feet thick. This clay unit behaves as semiconfining unit at the site with permeabilities on the order of  $10^{-8}$  cm/sec. The contact between the semiconfining unit and the alluvial sands and gravels is the second visibly distinct contact.

The surficial sediment overlying the semiconfining unit consists of a light brown to brown silt and silty clay layer extending from the surface of the gray clay to ground surface. Coefficients of permeability of this silty clay unit were found to range from  $2.5 \times 10^{-6}$  to  $2.4 \times 10^{-5}$  cm/sec. The contact between the semiconfining unit and the surficial sediments is the third visibly distinct contact observed within the alluvial material. Figure 2-3 presents the surface of the alluvial semiconfining unit as determined from this contact.

#### **2.3.4 Geophysical Logging**

To further evaluate the alluvial deposits overlying the Jackson Clay, four monitoring wells — 4MW-4, 2MW-7, OFFMW-1, and OFFMW-3 — were logged with borehole geophysical probes. These wells were installed by mud rotary drilling techniques and primarily logged by inspection of the drill cuttings. During installation, gravels were encountered that were too large to be washed out of the boring and were carried down to the bottom of the boring. This made it difficult to accurately detect lithologic changes that may have been present in the alluvial aquifer. Therefore, it was decided that geophysical logging was necessary to determine the thickness of the encountered gravels, and to determine if clay layers were present that may inhibit the downward migration of site contaminants.





2000 0 2000  
SCALE FEET

#### LEGEND

- - AGRICULTURAL WELLS
- - RESIDENTS INCLUDED IN WELL SURVEY
- × - RESIDENTS WITH WELLS, NOT IN SURVEY

LOCATIONS ARE APPROXIMATE

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FIGURE 2-4  
AGRICULTURAL AND RESIDENTIAL  
WELL LOCATIONS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 03/23/95 DWG NAME: CDRARWL1



The following geophysical tools were selected for their ability to be used in polyvinyl chloride (PVC) — cased holes. The geophysical log records generated by these tools can be found in Appendix C.

- The induction probe measures conductivity and is dependent upon the lithology and the interstitial water content of the material around the borehole.
- The gamma ray probe records the emissions of natural gamma radiation from the material around the borehole. These emissions are a function of clay content.
- The neutron probe measures the hydrogen atom concentration of the formation and bound water. The hydrogen atom concentration is a reflection of porosity.

All probes were decontaminated and calibrated before and after use in each monitoring well.

As discussed previously in this section, three visibly distinct units with obvious contacts were observed during well installation and mud logging: 1) surficial sediments above the semiconfining unit, 2) a semiconfining unit between the surficial sediments and alluvial sands and gravels, and 3) sands and gravels (the alluvial aquifer). Based on the geophysical logs, two additional units were detected within the sands and gravels of the lower alluvium. The five units identified within the alluvial sequences are discussed in the remaining paragraphs of this section.

#### **2.3.5 Lithologic Description**

Well 4MW-4 recorded a log bottom of 152.3 feet bgs with groundwater encountered at 26 feet bgs. As mentioned, there appears to be five distinct lithologic changes within the entire alluvial sequences identified by the natural gamma ray tool and supported by the induction tool. These changes have been subdivided into five discrete units within the alluvial sequences. Although the lithologic changes are described as units in the following descriptions, the alluvium was



deposited in the same depositional environment so the entire alluvial sequence is still considered one lithologic unit from one contiguous facies and depositional regime, as described in the discussion of regional hydrogeology. In descending order the lithologic changes and corresponding units are described as follows:

- Unit 1, from the surface to 32 feet bgs, consisting of silts, clays, and sands. Unit 1 corresponds to the surficial sediments.
- Unit 2, from 32 to 47 feet bgs, consisting of clays and silts. Unit 2 corresponds to the semiconfining unit.
- Unit 3, from 47 to 116 feet bgs, consisting of a coarsening downward sand sequence with clay stringers. Unit 3 corresponds to the upper 70 feet of the alluvial aquifer.
- Unit 4, from 116 to 131 feet bgs, consisting of clay. Unit 4 is in the middle section of the alluvial aquifer. This unit was not observed through visual logging of the borehole during well installation, but was detected during the geophysical logging.
- Unit 5, from 131 to 152.3 feet bgs, consisting of sand. Unit 5 is the lower section of the alluvial aquifer, immediately above the Jackson Clay. This unit was also undetected during visual logging of the monitoring well boring.

Gravels displaying the same electrical response and geochemical characteristics as sand could not be differentiated from the sand sequences based on the electric logs.

The induction log through Unit 3 shows a decreasing resistivity trend with depth, indicating a change in water chemistry. This is probably naturally occurring and not reflective of any downward migration of contamination.



The neutron log shows a relatively lower porosity zone from 116 to 144 feet bgs. Beneath this interval, porosity increases to the bottom of the monitoring well. This low porosity zone reflects the clays and some of the sands of Units 4 and 5.

Well 2 MW-7 recorded a log bottom of 145 feet bgs and, based on log correlations, also showed the same five distinct lithologic units within the alluvial deposits found in 4MW-4. The depth of the units are listed below:

- Unit 1, from surface to 27 feet bgs. Unit 1 corresponds to the surficial sediments.
- Unit 2, from 27 to 41 feet bgs. Unit 2 corresponds to the semiconfining unit.
- Unit 3, from 41 to 125 feet bgs. Unit 3 corresponds to the upper portion of the alluvial aquifer.
- Unit 4, from 125 to 133 feet bgs. Unit 4 is in the middle section of the alluvial aquifer. This unit was not observed through visual logging of the borehole during well installation.
- Unit 5, from 125 to 145 feet bgs. Unit 5 is the lower section of the alluvial aquifer, immediately above the Jackson Clay. This unit was also undetected during visual logging of the monitoring well boring.

Units 1 and 2 appear to have similar lithologic characteristics and log responses between wells 2MW-7 and 4MW-4. The natural gamma curve of Unit 3 in well 2MW-7 does not show the coarsening downward sand sequence nor the higher gamma counts as in 4MW-4, but instead displays smaller variations of lower gamma counts, indicative of a continuous sand and gravel sequence with little or no fines. This sequence also appears to be more porous than the



sequence encountered in 4MW-4. There is again an apparent change in water chemistry as indicated on the induction log in Unit 3 in 2MW-7. The change occurs at 76 feet bgs, where the resistivity drops from 55 ohm-meters to 38 ohm-meters. As in well 4MW-4, this is an apparent natural phenomena (possibly a change in salinity) and is not reflective of contamination, based upon the results of chemical analysis. The neutron log shows a less porous zone from 124 to 138 feet bgs which corresponds to the 116- to 144-foot zone in 4MW-4.

In summary, the units between the two monitoring wells can be correlated; however, there are lithologic differences based on log responses. Unit 3 in MW4 is a finer grained and less porous facies than in MW7, and MW7 has a thinner Unit 4 clay than MW4. As seen in the geophysical logs provided in Appendix C, monitoring wells OFFMW-1 & OFFMW-3 have the same lithologic characteristics as onsite wells 2MW-7 and 4MW-4. No detectable contamination was noted on any logs.

#### 2.3.6 Soil Classification

This section describes the upper 6 feet of soil near the site. All information was obtained from the *U.S. Department of Agriculture Soil Survey for Phillips County, Arkansas (November 1974)*.

The surface soil type at the site is the Convent Series. This series consists of somewhat poorly drained, level soils that develop on alluvial fans at the foot of Crowley Ridge, a major regional structural feature. The Convent soils have medium-to-low organic matter content, moderate permeability, and high available water capacity.

The following description is provided for the horizons of the Convent Series.

- Ap — 0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; friable; many fine roots; neutral; abrupt, smooth boundary.



- C1 — 7 to 21 inches, grayish-brown (10YR 5/2) silt loam; many medium distinct, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, platy structure; friable; common bedding planes; common fine roots; common pores; moderately alkaline; gradual, smooth boundary.
- C2 — 21 to 41 inches, grayish-brown (10YR 5/2) silt loam; common medium distinct, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, platy structure; friable; common bedding planes; few fine roots; common pores; few fine black concretions; mildly alkaline; abrupt, smooth boundary.
- C3 — 41 to 56 inches, grayish-brown (10YR 5/2) silt loam; common fine distinct, yellowish-brown mottles; weak, medium platy structure; friable; many bedding planes; mildly alkaline; abrupt, smooth boundary.
- C4g — 56 to 65 inches, dark-gray (10YR 4/1) silt loam; many fine, prominent, yellowish-red mottles; weak, coarse, platy structure; friable; common bedding planes; common pores; neutral; abrupt, smooth boundary.
- C5g — 65 to 73 inches, gray (10YR 5/1) silt loam; many fine, prominent, yellowish-red mottles; weak, coarse, platy structure; friable, few bedding planes; common pores; few fine black concretions; neutral.

#### 2.3.7 Site Hydrogeology

As described in Section 2.3.3, site investigations have identified three major distinct stratigraphic sequences beneath the site. The lowermost stratigraphic sequence encountered onsite is the Jackson-Claiborne Group, a stiff, dark gray clay with lignite. This sequence was identified from approximately 130 to 150 feet bgs. Overlying the Jackson-Claiborne Group is a relatively clean, fine-to-coarse, Quaternary-age alluvial sand with some gravel aquifer at depths ranging from the



Jackson Clay to a depth of approximately 40 to 50 feet bgs. This sand exhibits a fining-upward sequence that grades into the surficial silts, clays, and soils. The alluvial clay aquitard is typically present between 10 and 40 feet bgs, and consists predominately of a gray silty clay. The upper 10 feet consists of Convent series soil mixed with clay, gray and brown in color. This lithology is typical for most of east-central Arkansas.

The alluvial sands are recognized as a major source of groundwater for agricultural use in eastern Arkansas, usually yielding more than 500 gpm (Todd, 1983). The alluvial aquifer grades from a silty sand at the base of the surficial clays to a basal gravel at the Jackson Clay interface. This gradation sequence is typical for the region (USGS, 1982). Literature cites transmissivities of up to 35,500 square feet per day ( $\text{ft}^2/\text{day}$ ) (265,500 gpd/ft) in this region (USGS, 1982). The Jackson Clay acts as the lower aquitard for this aquifer, and isolates it from the next available drinking water source (the Sparta Sand) by several hundred feet.

Previous investigations onsite identified hydraulic conductivities ranging from, 70.9 feet per day ( $\text{ft}/\text{day}$ ) in the deeper portions of the alluvial aquifer to 0.14  $\text{ft}/\text{day}$  in the upper portions of the aquifer (GG&H, 1988). Phase II further characterized site hydrogeology. Section 6 discusses the hydrogeologic characterization.

#### **2.3.8 Meteorology and Air Quality**

Arkansas has a humid mesothermal climate characteristic of the southeast to south-central United States. The area rainfall is 50 inches per year, with most precipitation occurring between February and April. Phillips County is an attainment area for all primary and secondary air pollutants. The prevailing wind is southwest at an average speed of 8 mph and travels in that direction 12.3% percent of the time. The average annual temperature is 62.7°F.



## 2.4 1995 Residential and Agricultural Well Survey

During preparation of the 1995 *Interim Response Work Plan* (EnSafe, 1995) a residential and agricultural well survey was performed to identify water use in the vicinity of the site. Figure 2-4 shows the area surrounding the West Helena facility.

### 2.4.1 Residential Wells

Nineteen residences down- or across-gradient from the West Helena facility were either visited or observed during the residential well survey. These residences are shown on Figure 2-4 as either residences included or not included in the survey. Table 2-2 identifies all residences visited during the residential well survey. Wells formerly supplied all residences with domestic water; however, all homes have been connected to the city water system for over 10 years. Based on the survey, the wells are currently in various states of disrepair: some are capped, some are open with no pumps, others have non-usable pumps. Several residences on Tappen Road, northwest of the site, were also surveyed; all those residences are connected to city water. Several upgradient wells on Old Little Rock Road were also visited; some of these residences still have old wells, but all residents are on city water. None of the residences surveyed are currently using private wells as a source of drinking water.

Several of the downgradient residences are located within a 1 mile radius of the site. These residences are primarily on Phillips Road.

### 2.4.2 Agricultural Wells

Several agricultural wells were noted during the residential well survey. Consequently, data on agricultural wells near the West Helena facility were obtained from the U.S. Department of Agriculture Soil Conservation Service (SCS) extension office in Helena, Arkansas. These wells are also shown on Figure 2-4. These wells range from 120 to 125 feet deep, and are thus screened in the basal portion of the aquifer.

Table 2-3 identifies several of the agricultural wells shown on Figure 2-4. The wells identified in Table 2-3 are within 1 to 2 miles of the West Helena facility and are used primarily to irrigate cotton fields.



**Table 2-2**  
**Residential Well Survey Results**

Address	Owner	On City Water?	Comments
14 Phillips Road (332)	—	—	Well casing observed
34 Phillips Road (332)	—	Yes	Well casing, no pump
78 Phillips Road (332)	—	Yes	10 to 12 years on city water, pump does not work
98 Phillips Road (332)	—	—	Well casing, no pump
444 Phillips Road (332)	James Larry	—	Well casing, no pump
578 Phillips Road (332)	—	—	Well casing observed
50 Phillips Road (330)	—	Yes	17 years on city water, well is capped
114 Phillips Road (330)	O'Neal	Yes	20 years on city water, well is capped
328 Phillips Road	Barton Truck	Yes	No wells
867 Phillips Road (326)	—	Yes	No known wells
28 Phillips Road	BPS	Yes	No production wells
876 Old Little Rock Road	—	Yes	No well
6962 Old Little Rock Road	—	Yes	On city water, no motor on pump
7122 Old Little Rock Road	—	Yes	No wells
—	Steel Sales	Yes	No wells
7994 Old Little Rock Road	—	Yes	No wells
8102 Old Little Rock Road	—	Yes	No wells

**Note:**

- No Data Available
- Residents were not home during the survey. Any wells in the yard were noted.



Table 2-3  
Agricultural Well Survey Results

Well ID	Owner	Well Diameter (in)	Depth (ft)	Pump Type
157-2	Alan Hargraves	8	120	10 HP
157-4	—	6	120	10 HP
57-1	Harry Stephens	10	120	150 HP Diesel
57-2	Harry Stephens	10	120	100 HP Diesel
57-3	Harry Stephens	10	120	150 HP Diesel
57-4	Harry Stephens	10	120	100 HP Diesel
57-8	Harry Stephens	8	120	25 HP
57-9	Harry Stephens	10	120	150 HP
57-10	Harry Stephens	6	125	10 HP
57-5	Harry Stephens	10	120	100 HP
57-7	Harry Stephens	8	120	25 HP
107-1	W.A. Bailey	6	120	90 HP Electric
107-2	W.A. Bailey	8	120	25 HP

Note:

HP — Horsepower



### **3.0 SAMPLING PROCEDURES**

The following sections describe the specific sampling methods and procedures employed during the investigation. Soil and sediment sampling, well installation and completion, development, purging, groundwater sampling, and decontamination procedures are discussed in detail.

#### **3.1 Soil Sampling**

Soil samples were collected and analyzed while installing and completing the monitoring wells, soil borings, and hand-auger borings. Surface soil samples were also collected during the investigation. This section discusses the sampling procedures for each of the above-mentioned soil sample collection methods.

##### **3.1.1 Hand-Auger Borings**

Surface and shallow subsurface soil samples were collected using a stainless-steel hand auger. The hand auger consists of a stainless-steel sampling bucket attached to a 3-foot stainless-steel shaft topped by a T-handle. The following steps were conducted when collecting each hand-auger soil sample:

- The sampling bucket was advanced by turning the T-handle until the desired sampling depth was reached.
- A new decontaminated sampling bucket was used to collect the sample at the prescribed sampling depth.
- Once the bottom of the sampling interval was reached and the bucket retrieved, a portion of the soil was removed from the auger bucket with a stainless-steel spoon and placed in a clean glass jar for volatiles analysis.



- The remaining soil was then removed from the auger bucket with a stainless-steel sampling spoon and placed in a stainless-steel mixing bowl, where it was thoroughly homogenized to form a composite sample for chemical analysis.
- Splits of all samples were collected in labeled resealable plastic bags and tested for organic vapor content by using a headspace analysis technique employing a photoionization detector (PID).

Samples were shipped to the chosen laboratory at 4°C via overnight courier for laboratory analysis under strict chain-of-custody procedures.

### 3.1.2 Drill Rig

The soil borings were advanced using a 4.25-inch inner diameter (ID) hollow-stem auger (HSA) drilling system. Soil sampling began at the surface and continued at the desired sampling intervals until the terminal depth was reached.

During auger drilling and sampling, boreholes were continuously monitored with a PID or flame ionization detector (FID), and a Miniram Aerosol monitor to detect any organic vapors and dust particles released through drilling.

In each soil boring installed with the drilling rig, samples were collected using a standard 5-foot continuous soil sampler consisting of a split tube and shoe. The decontaminated sampler was attached to the drilling rods and lowered through the HSAs. The lead end of the sampler extended a few inches beyond the cutting head and locked into place. As the augers were turned, the sampler filled with undisturbed soil. The following steps were followed during sample collection:



- Once the augers had been advanced 5 feet (the length of the sampler), the full sampler was withdrawn from the augers, disconnected from the drilling rods, and opened by the site geologist.
- Once opened, a sample was immediately collected for volatile organic compounds (VOC) analysis with a stainless-steel sampling spoon,
- The sample core was then screened with a PID/FID and the sample lithology described on the boring log. Lithologic descriptions of characteristics included color, grain size, sample quantity, PID/FID readings, and any staining, odor, or discoloration were recorded.
- A portion of the sample was placed in a stainless-steel bowl and mixed with a stainless-steel spoon. Once homogenized, the soil was placed in the appropriate sample containers and packed on ice in a cooler for transport to the site trailer.
- A portion of the sample was also placed in a labeled resealable plastic bag for headspace analysis.
- Upon completion of the boring, the headspace in each bag was analyzed with a PID for each sampling interval. Results were recorded in the field logbook.
- The sample interval with the highest headspace concentration, along with the uppermost and bottom sampling intervals, was submitted for laboratory analysis.

Upon completion of each soil boring, the bore hole was backfilled with a cement-bentonite grout mixture. This mixture was pressure-grouted through a tremie pipe by starting at the base of the borehole and working up to the surface. The location of each boring was marked for future reference on a site map. Soil boring logs for each boring are provided in Appendix A.



### **3.1.3 Geoprobe Soil Sampling**

Some soil borings were installed with a Geoprobe rig. The Geoprobe is a direct push technology system that operates by pressing hollow 1-inch diameter rods with attached sampling tools into the ground with a hammer-assisted hydraulic press. Soil samples were collected as follows:

- A dedicated clear plastic sampling sleeve was installed in the decontaminated 2-foot sampling tool that was then connected to the lead rod.
- The rods were pressed into the ground using the hydraulic press. An internal hammer was activated when the formation became too firm and dense to allow penetration by the hydraulics alone.
- Once the desired sampling depth was reached, actuator rods were lowered through the open center of the drill rods to the top of the sampling tool, releasing the catch pin that closes the sampling tool.
- The actuator rods were removed and the Geoprobe rods were pressed an additional 2-feet, forcing the sample into the plastic sleeve.
- The rod string was extracted via rig hydraulics and the sampling tool removed and opened to release the sampling sleeve.
- Approximately 6 inches of the 24-inch sleeve were cut off. The soil in the 6-inch portion was extruded into a labeled resealable plastic bag for headspace analysis. The remaining 18 inches of the tube was then capped and labeled. The sample interval with the highest headspace concentration, along with the uppermost and bottom sampling intervals, was submitted for chemical analysis at the offsite contract laboratory or analyzed with the onsite gas chromatograph (GC).



### **3.2 Monitoring Well Installation**

During this investigation both Type II and Type III groundwater monitoring wells were installed. Type II wells were installed in the perched aquifer encountered in some locations at a depth of approximately 12 feet. Type III groundwater monitoring wells were installed in the alluvial aquifer beneath the clay confining unit. The borings for the wells were sampled continuously for lithology and chemical analysis. The choices of well types and depths were based on the lithologic data obtained during boring installation. Well schematics for both types of wells are provided in Figures 3-1 and 3-2. The following sections describe the well installation procedures for both Type II and Type III wells.

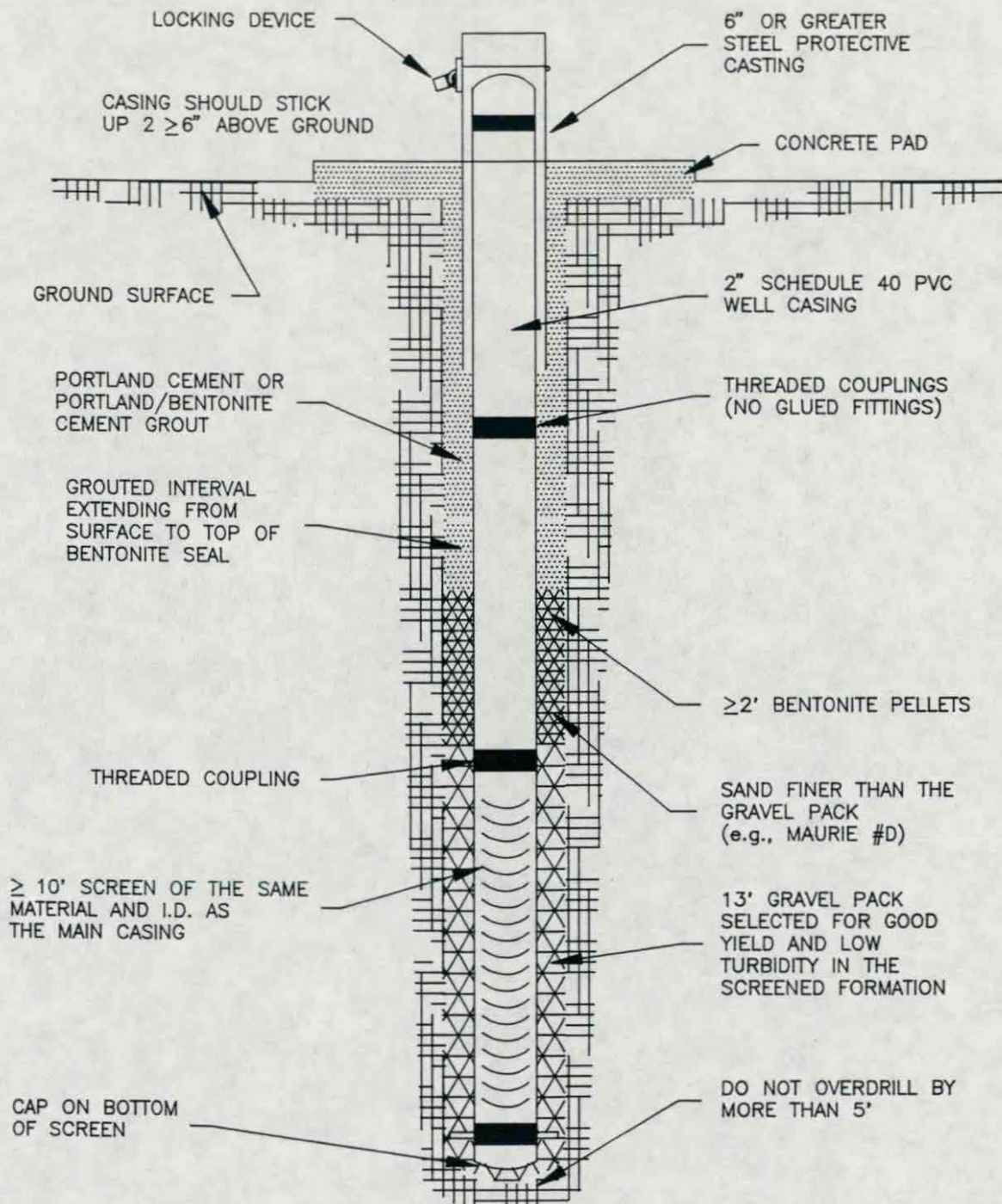
#### **3.2.1 Type II Well Installation**

The Type II wells were installed approximately 7 feet into the first encountered saturated zone. The soil borings for these wells were sampled for lithologic description and chemical analysis. Decisions on well types and depths were based on the lithologic data obtained during boring installation and from information obtained from past investigations. The following section describes the well installation procedures for the Type II wells.

- The well boring was installed by advancing 3.75-inch ID or 4.25-inch ID HSAs to a point approximately 7 feet into the saturated zone.
- Once the target depth was reached, the well screen and riser piper were lowered through the augers to the bottom of the boring. The wells consisted of a 10-foot length of 2-inch diameter, 0.010-inch slot, flush-threaded, Schedule 40 PVC well screen attached to a length of 2-inch diameter, flush-threaded, Schedule 40 PVC riser pipe.
- A graded 20/40-sized silica sand filter pack was placed around the screen through the HSAs. The filter pack extended at least 2 feet above the top of the well screen. Depth to the top of the filter pack was checked constantly during placement to ensure that the sand pack was even and not bridging.



TYPICAL ILLUSTRATION OF MINIMUM SPECIFICATIONS  
FOR MONITORING WELL CONSTRUCTION



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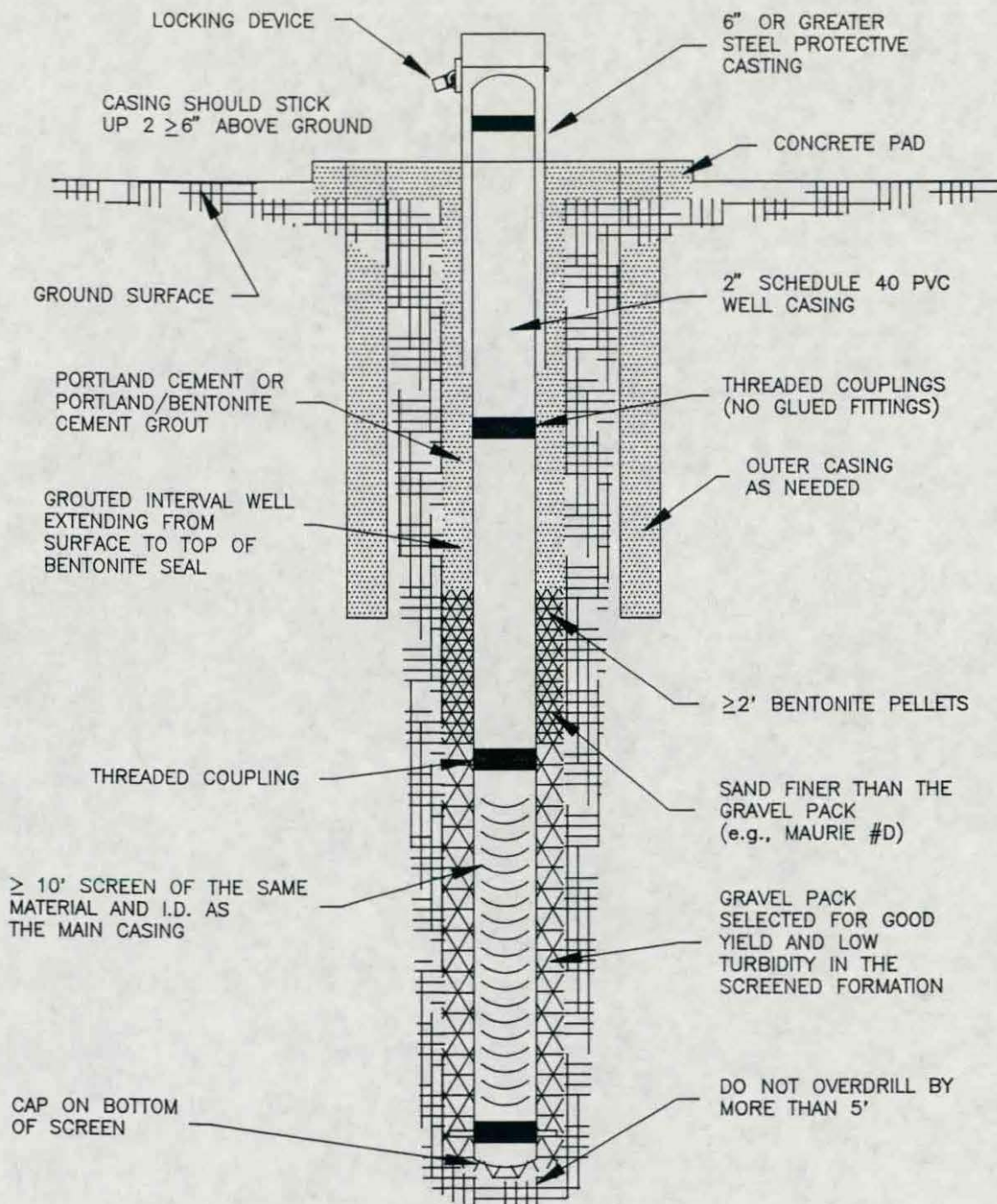
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FIGURE 3-1  
TYPE II  
MONITORING WELL DESIGN

DWG DATE: 06/28/96 DWG NAME: C2162WS2



TYPICAL ILLUSTRATION OF MINIMUM SPECIFICATIONS  
FOR MONITORING WELL CONSTRUCTION



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FIGURE 3-2  
TYPE III  
MONITORING WELL DESIGN

DWG DATE: 06/28/96 DWG NAME: C2162WS1



- A bentonite pellet seal, a minimum of 2 feet thick, was placed above the filter pack through the augers. The bentonite pellets were hydrated with distilled water above the water table, a zone where natural hydration would not occur.
- After the pellet seal had hydrated, the remaining annulus of the borehole was pressure-grouted from the bentonite seal to ground surface through a tremie pipe. The grout consisted of a potable water, Portland cement, and bentonite powder slurry.

### **3.2.2 Shallow Type III Monitoring Well Installation**

Type III groundwater monitoring wells were installed in the alluvial aquifer beneath the clay confining unit. The surface casings in these wells were installed to isolate and prevent perched groundwater from percolating down and cross-contaminating the alluvial aquifer. The soil borings for the wells were sampled for lithologic description and chemical analysis. Decisions on well types and depths were based on the lithologic data obtained during boring installation and from information obtained from past investigations. The following section describes the well installation procedures for the shallow Type III wells.

- After soil samples were collected from the well boring with 4.25-inch ID HSAs, the boring was overdrilled with 8.25-inch ID HSAs to the top of the alluvial clay confining unit.
- Once the top of the confining unit was reached, the augers were removed and the surface casing was lowered to the bottom of the boring. Surface casings were either 6 inches or 8 inches in diameter and constructed of decontaminated Schedule 40 PVC. During the installation process, the hole was continuously monitored to ensure that no sloughing or caving was occurring.



- Once in place, the surface casing was hydraulically pressed approximately 1 foot into the clay unit with the drill rig hydraulics. A bentonite pellet seal was placed at the bottom of the surface casing annulus to ensure a good bottom seal between the casing and the confining unit.
- Once the pellets had adequate time to hydrate, the remaining annulus around the casing was grouted to ground surface with a potable water, Portland cement, and bentonite powder slurry.
- After the grout around the casing had cured at least 12 hours, 4.25-inch HSAs were lowered through the surface casing, and the soil boring was advanced 10 feet below the bottom of the confining unit into the lower saturated unit.
- The well screen and riser were installed through the HSAs. The wells consisted of a 10-foot length of 2-inch diameter, 0.010-inch slot, flush-threaded, Schedule 40 PVC well screen attached to a length of 2-inch diameter, flush-threaded, Schedule 40 PVC riser pipe.
- A graded 20/40-sized silica sand filter pack was placed around the screen. The filter pack extended at least 2 feet above the top of the well screen.
- A bentonite pellet seal, a minimum of 2 feet thick, was placed above the filter pack. The bentonite pellets were hydrated with distilled water above the water table where natural hydration would not occur.
- After the pellet seal had hydrated, the remaining annulus of the borehole was pressure-grouted from the bentonite seal to ground surface through a tremie pipe. The grout consisted of a potable water, Portland cement, and bentonite powder slurry.



### **3.2.3 Intermediate Depth Groundwater Screening**

Intermediate depth groundwater screening was conducted with a Geoprobe rig. During groundwater screening, samples were collected at incrementally increasing depths for chemical analysis. An estimate of the vertical extent of groundwater contamination was determined based on the vertical profile established by the screening sampling. Intermediate-depth Geoprobe groundwater screening was conducted as follows.

- At each location, soil/well boring logs from Phase I and Phase II of the investigation were consulted to determine the approximate depth to the bottom of the clay confining unit.
- The Geoprobe rig was set up over the selected location and the rods were pressed into the ground to within a few feet of the clay-sand contact.
- Soil samples were collected continuously with the Geoprobe for lithologic interpretation to determine when the sand aquifer was encountered. Collection methods were the same as detailed in Section 3.1.3.
- The first groundwater screening sample was collected in the alluvial aquifer with the Geoprobe rig immediately below the clay-sand contact once this contact was established.
- Subsequent groundwater samples were collected at roughly 20-foot intervals to a maximum depth of 100 feet.

Groundwater samples were collected by attaching a decontaminated groundwater sampling tool to the Geoprobe rods and pushing the sampler to the desired depth. The actuator rods were lowered through the rods to activate the sampling tool. The rods were then extracted 2 feet to expose the sampling tool screen. A decontaminated check valve was attached to a length of



well-dedicated Teflon tubing which was then lowered through the push rods to the top of the groundwater sampling tool. The open end of the tubing was inserted into a sample container. The tube was then grasped and rapidly moved up and down, bringing the water to the surface through the tube and into the container. The rods were extracted, the sampler decontaminated and the process was repeated at each of the deeper sampling intervals.

#### **3.2.4 Deep Type III Monitoring Well Installation**

Six deep monitoring wells have been installed during this investigation using mud rotary drilling techniques and screened at or near the top of the Jackson Clay. Drilling and installation problems were encountered at both onsite well locations during Phase II due to the coarse gravel layers (believed to be pebble to cobble size) interbedded in the alluvial formation immediately above the Jackson Clay. While drilling these wells, sloughing and collapse resulted in binding and hang-up of the drill bit and problems with well completions. During deep drilling operations in Phase III, a larger pump was used to circulate the drilling fluids during installation of the remaining wells. As a result, it was possible to install the deep offsite wells to the Jackson Clay surface. A brief narrative is presented to provide details concerning the deep-well installations and the problems encountered.

#### **Onsite Wells**

While installing the first deep onsite well, 2MW-7, gravel was encountered in the lower portions of the alluvial section. Possibly due to inadequate pump pressure or mud weight-viscosity, the gravel could not be lifted and circulated into the mud pit despite continued washing and bottoms-up cycles. The sloughed gravel followed the bit down, causing continual drilling problems and delays. Attempts were made to retrieve samples of the section to confirm the presence of the Jackson Clay. Repeated sampling attempts with both split spoons and Shelby tubes were unsuccessful and only small amounts of gravel were recovered. Drilling continued to the estimated top of clay at 145 feet and continued to 155 feet with repeated sampling attempts to confirm the top of clay. At 155 feet, the gravel buildup led to a decision to suspend drilling and



set the well. Since the projected target depth of the well had been surpassed, this seemed logical even though a confirming sample of the Jackson Clay could not be retrieved. It also became apparent that drilling needed to be suspended based on poor hole performance, since further drilling might quickly lead to a gravel-bound bit, resulting in a lost bit and possibly lost drill pipe in an abandoned hole. During the trip out of the hole, more gravel collapse was noted. Although the well was pushed to bottom immediately after removing the bit, the bottom of the hole could not be reached. Apparent gravel collapse in the last 10 feet of the hole resulted in the well being set at a depth of 145 feet, its proposed target depth.

While installing onsite well 4MW-4, abundant quantities of gravel were also encountered in the lower portions of the alluvial section. By comparison, fewer complications due to gravel buildup developed in this hole. Upon reaching the projected top of the Jackson Clay at 145 feet, a confirming split-spoon sample was attempted. The split spoon was retrieved and 2 inches of organic, lignitic clay and peat were recovered. This sample seemed to confirm the supposition that the Jackson Clay had been reached since it is typically organic and commonly lignitic. With this sample confirmation, the well was set at 150 feet.

### **Offsite Wells**

Two deep offsite well pairs were installed, using mud rotary drilling techniques, approximately three-quarters of a mile hydraulically downgradient of the site. Based on the experiences and problems encountered during previous deep drilling, a larger pump with greater capacity was used for circulation in the boreholes. As a result, fewer problems were encountered during drilling and the wells were completed to the target depths.

Each deep well pair consists of one well screening an 18-foot section of the aquifer at the Jackson Clay surface, and a shallower well screening a 20-foot section of the aquifer approximately 9 feet above the deeper well screen. Each deep well was completed with a 20-foot screen. In the deeper wells (OFFMW-1 and OFFMW-3) the screens were set 2 feet



into the Jackson Clay, with 5-foot sumps to contain any dense nonaqueous phase liquids (DNAPL) that may flow into the well. Each deeper well was installed at a depth approximately 7 feet below the contact of the Jackson Clay and the alluvial aquifer (5-foot sump and 2 feet of screen). The remaining portion of the well screen extends 18 feet above the surface of the Jackson Clay, screening the lower coarse sands and gravel of the alluvial section.

At OFFMW-1 the Jackson Clay was encountered at 137 feet bgs. The total depth of this well is 143.5 feet. The screened interval extends from 138.5 to 118.5 feet. The shallower well in this pair (OFF-MW2) was screened from 110 to 90 feet.

The Jackson Clay surface was encountered at 126 feet at OFFMW-3. The well was completed at a depth of 133 feet with a screened interval of 128 feet to 108 feet. The shallower well in this pair (OFFMW-4) was completed at a depth of 99 feet and screened from 99 to 79 feet bgs.

All wells were installed and completed in the following sequence. The bit and the drill pipe were removed from the hole and the screen attached to the riser was immediately lowered into the borehole. The drilling mud was thinned with potable water to allow the native material to collapse around the screen. Some filter sand was tremied to bring the sand above the top of the screen to the prescribed depth. After a number of attempts with noncoated pellets, time-release bentonite pellets were placed above the filter pack with a 1-inch tremie pipe to provide a seal between the grout, the filter pack, and the well screen. After the bentonite was allowed to hydrate at least 12 hours, the remaining annulus was grouted to ground surface through a tremie pipe with a Portland cement and bentonite powder slurry.

Deep well materials were similar to shallow well materials. The wells were constructed of flush-threaded, 2-inch diameter, Schedule 40 PVC riser pipe, and 0.01-inch slot, 10-feet long Schedule 40 PVC well screens.



### **3.2.5 Monitoring Well Completion**

All shallow and deep wells at the site, once installed, were completed with concrete pads fitted with either aboveground or flush-mount protective covers. The wells were completed as follows:

- To facilitate groundwater sampling of wells in grassy areas, approximately 2.5 feet of well pipe were left extending above the ground surface at each of the well sites. To protect the wells and ensure their integrity, steel protective casings with locking covers were set over the well pipes in concrete pads (4' x 4' x 6") that slope away from the well casing. A steel guard post was set in the concrete at each corner of the pad.
- Wells in paved areas were completed flush with the ground surface. The well casing was cut to extend approximately 3 to 4 inches bgs. A watertight manhole assembly was then placed around the well casing and cemented into place. The manhole and surrounding concrete were placed slightly above the surrounding paved surface to ensure surface water drained away from the wellhead.
- All onsite monitoring wells were surveyed by a State of Arkansas-registered land surveyor to the nearest 0.01 foot incorporating USGS North American Datum '83. Reference to this survey is clearly stated on all plats, drawings, and figures, along with the benchmark reference. A permanent mark was placed at the top of each well casing so accurate and consistent groundwater levels could be measured.
- All monitoring well installation notes, calculations, descriptions, and observations were recorded in the field logbook. In addition, soil boring and well construction logs were produced that accurately depict all construction details of the finished wells. These construction details include total depth, date completed, lithology where sampled, depth to the filter pack and the seal, and a measured static water level.



### **3.3 Monitoring Well Development**

Wells were developed once the cement grout in the annular space had been allowed to cure at least 24 hours. The wells were developed to remove the fine clay and silt particles from the geologic formation near the well intake to reduce turbidity in groundwater samples. Well development continued until groundwater turbidity was reduced. Wells were developed with either a decontaminated Teflon bailer, a PVC Brainard-Kilman hand pump, or 2-inch stainless-steel Grundfos pump. All water generated during well development was containerized in steel 55-gallon drums.

### **3.4 Groundwater Sampling**

Groundwater sampling began once the wells were completed and the turbidity of the groundwater had been reduced through development. Groundwater was sampled to provide data pertaining to the groundwater physical parameters and chemical constituents.

The following activities preceded the groundwater sampling event:

- Static water levels were measured and recorded for each monitoring well. Measurements were made to the nearest one-hundredth of a foot using an electronic water level indicator. The data from these measurements were referenced to mean sea level.
- Clean plastic sheeting was spread around the well to contain any spilled purge or sample water.
- At least three well casing volumes were purged from each shallow well before sampling. Only one well volume was purged from the deep wells since these wells were developed and purged within 12 to 15 hours of sampling. Purging was accomplished using a peristaltic pump with dedicated Teflon tubing or a decontaminated Teflon bailer. The casing volume of each well was calculated by determining the height of the water column



in the well using the difference between the static water level measurement and the known depth. This number was then multiplied by a volume/foot constant (0.164 gallons/foot for a 2-inch well) to derive the volume of water in the casing. All water produced during purging was containerized in 55-gallon drums. Following water removal, each well was allowed to recover before sampling.

- Temperature, pH, turbidity, and specific conductance were measured and recorded for each casing volume purged, using a portable water quality meter.

Groundwater samples were collected from each well using either a decontaminated Teflon bailer with a one-way ball valve, a peristaltic pump with dedicated Teflon tubing and decontaminated transfer cap and bottle, or a decontaminated centrifugal pump with dedicated Teflon tubing. The samples were collected in the appropriate preserved sample containers.

### **3.5 Decontamination Procedure**

To prevent cross-contamination during sampling and well construction, all drilling and sampling equipment was decontaminated between each boring, sampling interval, and well. All decontamination procedures requiring pressure washing were conducted at the decontamination station, which was established and constructed before sampling began. The decontamination station consisted of a double-layered plastic floor surrounded by a 12-inch berm to collect wastewater. A sump was excavated beneath the plastic in the downgradient corner of the floor to facilitate retrieval of the waste decontamination water. A submersible pump transferred the water from the sump into labeled 55-gallon investigation-derived waste (IDW) drums.

All HSAs and drill rods were decontaminated before use at each boring/well location as follows:

- Augers and drill rods were steam-cleaned with a high-pressure hot potable water wash. Any particulate matter that was not removed from the equipment with the pressure wash was scrubbed with a brush. The wash was followed by a high-pressure, hot water rinse.



- Following the rinse, the equipment was allowed to air dry, then wrapped in plastic before transport to the next boring location.

All continuous sampling barrels and shoes, sampling tubes, stainless-steel sampling bowls, spoons, hand augers, and Teflon bailers were decontaminated as follows:

- The sampling equipment was brush scrubbed with a potable water and Liqui-Nox wash.
- The equipment was rinsed with potable water.
- The equipment was rinsed with laboratory-grade isopropanol.
- The equipment received a final deionized water rinse.
- After air drying, the equipment was wrapped in aluminum foil or plastic for transport to the next sampling location.

The water-level indicator was decontaminated between wells by rinsing with potable water, a laboratory-grade isopropanol rinse, and a deionized water rinse.

### **3.6 Investigation Derived Waste (IDW)**

All IDW (soil cuttings, development water, purge water, and decontamination water) was containerized in U.S. Department of Transportation (DOT)-17H 55-gallon steel drums. When a drum was filled or an investigation site completed, the drum was labeled with the content's matrix and source, the site number, well or boring number from which the waste was generated, and the date of waste generation. All IDW drums were staged in a secure location at the Cedar Chemical facility until analytical results were received, and waste characterization could be completed.



For spoil soil cuttings and groundwater from the wells, analytical results from the soil and groundwater analyses have been used to characterize the waste and determine whether hazardous constituents are present. Separate batch samples collected from the decontamination water were used for characterization. These batch samples were analyzed for site constituents.

For spoil soils, if the analytical results show the soil boring samples are hazardous, those soil cuttings will be stored at the facility less than 90 days while proper disposal is arranged. If the analytical results show that the soil boring samples are nonhazardous, the nonhazardous waste soil from that boring will be spread across the investigation site.

If the analytical results show that the groundwater and decontamination water samples are hazardous, the monitoring well purge water from that well will be stored at the investigation site less than 90 days while proper disposal is arranged. If the analytical results show that the groundwater samples are nonhazardous, the monitoring well purge water from each corresponding well will be sent to the onsite water treatment facility.

### **3.7 Sample Nomenclature**

All samples locations have been numbered using a standardized labeling system. An example of this sample designation system is 1SB-2 (5-10'). In this sample identification numbering system, 1 represents the site from which the sample was collected, SB indicates that the sample was collected from a soil boring, 2 is the boring number, and (5 - 10') indicates that the sample was collected from a 5-foot interval ranging from 5 to 10 feet bgs. Another example sample identification number is 4HA-1 (0 - 1') indicating a sample collected from Site 4 at the first hand-auger boring location, and the sample was collected from 0 to 1 foot bgs.



The sample type designations are:

- HA — Hand-Auger Boring
- SB — Soil Boring
- MW — Monitoring Well. Identification numbers for soil samples collected during the installation of monitoring well borings will include the depth of sample collection in parenthesis. Groundwater samples collected from a well will not have this depth included. Example: soil 1MW-2 (5-10'), groundwater 1MW-2.
- GB — Geoprobe Boring. Soil samples collected with the Geoprobe are designated as SB. Groundwater samples, however, are designated as GB to inform the reader that the water was collected as a grab sample and that it is not reproducible.
- SAI — Source Area Investigation Boring. During the third phase of the investigation, the suspected 1,2-dichloroethane source area was subdivided into a grid with samples collected at each grid intersect. All soil borings collected from this grid were identified as SAI to inform the reader that the intent of these samples was to determine the source of 1,2-dichloroethane contamination.
- PZ — Piezometer
- BG — Background
- SED — Sediment
- LB — Lithologic Boring



Site designation numbers are consistent with the site number except for the existing and offsite monitoring wells. Rather than a site number, all existing monitoring wells are identified with an "E" for existing. For example EMW-1, signifies existing monitoring well No. 1. All offsite wells are identified with "OFF" for offsite. For example OFFMW-1, indicates offsite monitoring well No. 1.



#### **4.0 SAMPLING PLAN**

The following sections describe the sampling methods and procedures employed at each site during Phases I, II and III of the FI. Brief descriptions of each of the nine sites are followed by paragraphs detailing specific sampling locations and protocols for each phase of soil and groundwater sampling. Phase I soil and groundwater samples were typically analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and Resource Conservation Recovery Act (RCRA) metals. Phase II and III chemical analyses for soil and groundwater were "tailored" to address only those specific compounds detected during Phase I of the FI. All analytical results are presented in Appendix D.

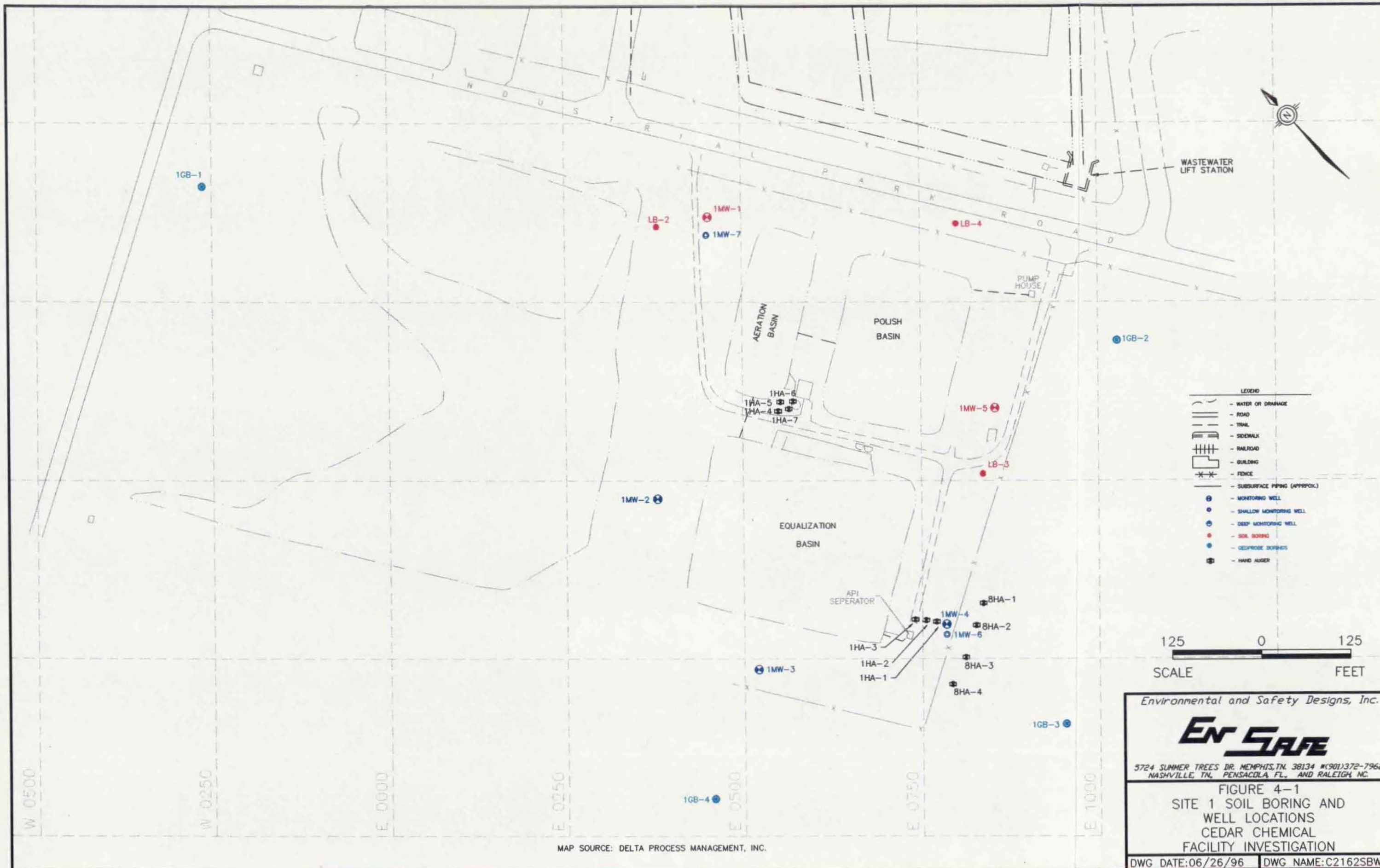
##### **4.1 Background Soil Sampling**

In order to establish baseline concentrations of VOCs, SVOCs, pesticides, and metals, three background soil samples collected from soybean fields adjacent to the Cedar Chemical facility were analyzed for VOCs, SVOCs, pesticides, and RCRA metals. BGHA-1 was collected in the field northeast of the Unit 5 and BGHA-2 was collected in the field south of Site 2. BGHA-3 was collected in the field southwest of the Site 1 equalization basin. Analytical results for the background soil samples are presented in Table 5-1 in Section 5.

##### **4.2 Site 1 Sampling (SWMUs 63, 64, 65, and 68)**

Site 1 comprises four Solid Waste Management Units (SWMUs): Wastewater Tank 2 (SWMU 63), the Flow Equalization Basin (SWMU 64), the Aeration Basin (SWMU 65), and the Polish Pond (SWMU 68), that are part of the wastewater treatment system. The treatment system is in the southeast corner of the site across Industrial Park Road. This site was investigated to determine whether the treatment ponds, or reported spills by the API Separator and Wastewater Tank 2, had impacted the soil or groundwater. Site 1 and all associated sampling locations and wells completed during Phases I and II (no borings were installed during Phase III) are shown in Figure 4-1.





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FIGURE 4-1  
SITE 1 SOIL BORING AND  
WELL LOCATIONS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/26/96 DWG NAME: C2162SBW



#### **4.2.1 Site 1 — Phase I Soil**

Continuous soil samples were collected from all seven monitoring wells installed at Site 1 (1MW-1, 1MW-2, 1MW-3, 1MW-4, 1MW-5, 1MW-6 and 1MW-7). Wells 1MW-1 through 1MW-5 are Type II wells installed and screened in the first encountered saturated zone to determine whether the perched water had been impacted by the Site 1 wastewater treatment ponds. Type III wells, 1MW-6 and 1-MW-7, were installed and screened in the alluvial aquifer, immediately below the clay aquitard. These wells were installed to determine if any contaminants in the perched water had migrated vertically through the confining unit to the alluvial aquifer. All samples collected from the monitoring well borings were analyzed for VOCs, SVOCs, pesticides, and metals.

Three samples were collected from the berm below the API Separator (1HA-1, 1HA-2, and 1HA-3) and one soil sample was collected from each of the two stained areas around Wastewater Tank 2 (1HA-4 and 1HA-5). These samples were collected to determine if the reported releases from these two units had impacted the surrounding soil. The samples were collected with a hand auger from 0 to 12 inches and analyzed for VOCs, SVOCs, pesticides, and metals.

Three sediment samples (1SED-1, 1SED-2, and 1SED-3), one from each treatment pond, were collected with a petite ponar dredge sampler. The samples were analyzed for VOCs, SVOCs, pesticides, and metals.

#### **4.2.2 Site 1 — Phase II Soil**

During Phase II of the FI, soil samples were collected for chemical analysis while installing one shallow monitoring well (1MW-7) into the alluvial aquifer, and from two hand-auger borings near the wastewater tank. The samples were analyzed for SVOCs and pesticides.

To determine the vertical extent of contamination detected in the Phase I soil samples, Phase II hand-auger borings (1HA-10 and 1HA-11) were sampled at 3-foot intervals to a depth of 12 feet bgs.



Along with the samples for chemical analysis, three lithologic borings were installed at Site 1 (1LB-3, 1LB-4, and 1LB-7). Lithologic samples were collected from these borings to aid in mapping the surface and bottom of the alluvial clay.

#### **4.2.3 Site 1 — Phase I Groundwater**

Six groundwater monitoring wells were installed at Site 1 during Phase I of the investigation. While installing the first monitoring well boring, a perched saturated zone was encountered at approximately 12 feet bgs on the surface of the clay semiconfining unit described in the site geology discussion. The perched zone was considered to be a collection point for water infiltrating through surficial fill material, so five Type II monitoring wells were installed and screened in that zone. The 10-foot well screens for each well were installed approximately 7 feet below the water table. Once all Site 1 wells were installed, headspace readings were collected from the wellheads. A shallow Type III monitoring well was then installed in the alluvial aquifer adjacent to the well with the highest headspace reading. The top of the 10-foot well screen was placed immediately below the clay semiconfining unit. This well was also downgradient from the wastewater treatment ponds. All Site 1 monitoring wells were analyzed for VOCs, SVOCs, pesticide, metals, ammonia, bicarbonate, chloride, fluoride, sulfate, nitrate, and cyanide.

#### **4.2.4 Site 1 — Phase II Groundwater**

Contamination was detected in the Phase I wells screened in the perched zone and the shallow well installed in the alluvial aquifer. During Phase II, a second shallow well (1MW-7) was installed in the alluvial aquifer adjacent to perched well 1MW-1 and upgradient from the wastewater treatment ponds. This well was also screened immediately below the clay semiconfining unit. Constituent concentrations in upgradient well 1MW-7 were compared with downgradient concentrations in well 1MW-6. Based on this comparison, conclusions were made regarding the wastewater treatment ponds' contribution to groundwater contamination in the alluvial aquifer. These conclusions are presented in Section 7 of the report. The Phase II Work



Plan called for installing nested well pairs at three offsite locations downgradient from the treatment ponds. Instead, groundwater samples were collected with a Geoprobe sampling rig, because it provided greater flexibility in vertical delineation of the offsite plume.

Due to excessive rainfall, the proposed well location in the wetland area was inaccessible to the drill rig. Since the Geoprobe rig was mounted on a four-wheel drive truck, it was used to collect the groundwater sample from this location. The shallow boring (1GB-1) was installed in the wetland area southwest of the Industrial Park Road/Highway 242 intersection. One groundwater sample was collected from this boring at a depth of approximately 40 feet.

Of the three locations sampled offsite, two were on the neighboring Norac Chemical Corporation property to the east (1GB-2 and 1GB-3), and one was in the bean field to the south of the treatment ponds (1GB-4). All Phase II Site 1 groundwater samples were analyzed for VOCs, SVOCs, lead, and arsenic.

#### **4.3 Site 2 Sampling (SWMUs 69, 70, and 71)**

These units are part of a three-pond wastewater treatment system used from 1970 to 1978. In 1978 the ponds were drained by a disposal contractor and filled with soil from the Cedar Chemical property. Ponds 1 and 2 were approximately 120 feet x 150 feet x 10 feet deep and Pond 3 was approximately 30 feet x 150 feet x 4 feet deep. The units were constructed of earthen fill and were not lined. Pond 3 also contained limestone for acid neutralization. The units received wastes from onsite production processes and some wastes generated offsite until 1978, including propionic acid, calcium chloride solution, and neutralized sulfuric acid waste. This list does not include the wastes disposed at this site by Helena Chemical Company. Helena formulated between 100 to 200 compounds, any of which could have been disposed of in these ponds. Contamination of the surface and subsurface soil has been confirmed by the U.S. Environmental Protection Agency (EPA).



This site was investigated to determine if the unlined ponds had impacted soil or groundwater. The ponds are currently covered, and it is expected that contaminant contributions to the environment have been reduced as a result. Site 2 and all associated sampling locations are shown in Figure 4-2.

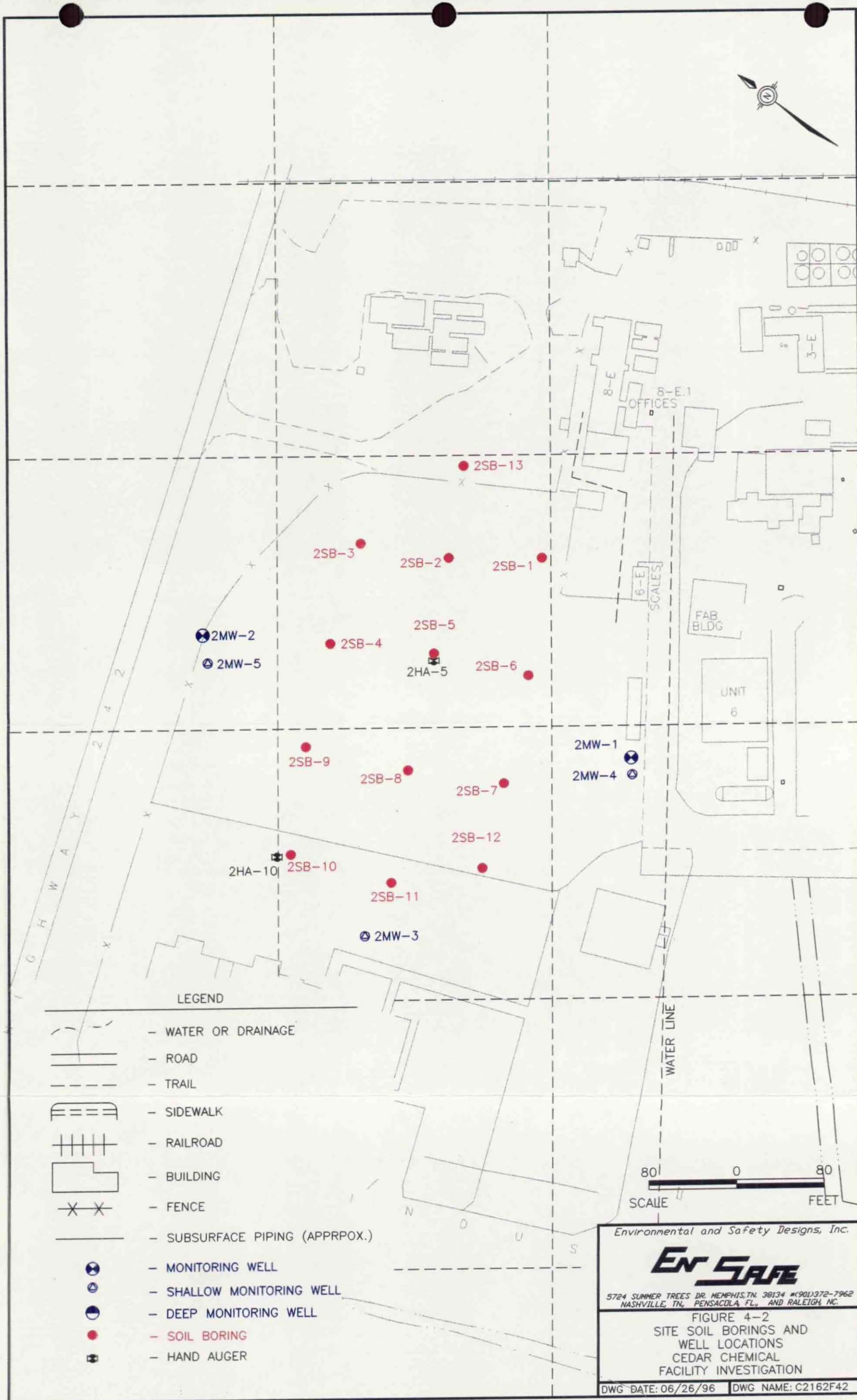
#### **4.3.1 Site 2 — Phase I Soil**

The purpose of Phase I sampling was to determine the boundaries of the ponds. A sampling grid was established to thoroughly cover Site 2 and to improve the chances of delineating the boundaries by installing borings both within and outside the ponds. The grid was set up with sampling points in the center of each grid square resulting in 12 boring locations (borings 2SB-1 through 2SB-12).

The soil borings were also installed to determine the vertical extent of the contamination detected in the 1985 Ecology and Environment Inc. (E&E) investigation. Each boring was intended to be sampled at 1-foot intervals and screened with a Dexsyl L2000 chloride/polychlorinated biphenyl (PCB) analyzer to detect the presence of chlorinated pesticide reported by E&E. There were some deviations to the sampling plan at Site 2 due to matrix interference problems with the screening instrument and due to difficulties locating the pond boundaries with the aerial photographs. The following sections describe the plan deviations and the actual sampling procedures implemented at this site.

Once screening was completed, the 1-foot interval with the highest chloride reading was to be submitted to the laboratory for VOC, SVOC, pesticide, and metals analyses. Additionally, the two 1-foot intervals with a chloride content near that of background samples collected from offsite were to be homogenized and submitted to the laboratory for VOC, SVOC, pesticide and metals analyses, thus establishing the vertical extent of contamination.







However, when the onsite soil screening began, matrix interference problems were encountered during the analysis with the Dextsyl chloride analyzer. Once it was determined that the data obtained from this screening method were unusable, the sample collection and screening procedures were amended and conducted as described in Section 3.1. All Site 2 soil borings were installed to 30 feet bgs except 2SB-3, which was terminated at 25 feet bgs.

All samples selected for chemical analysis were submitted to the laboratory for VOC, SVOC, pesticide, and metals analysis.

#### **4.3.2 Site 2 — Phase II Soil**

Except for one data gap, the boundaries of the Site 2 ponds were reasonably delineated during Phase I. To fill this gap, one additional soil boring (2SB-13) was installed just outside the fence to the north of the site to confirm the ponds' northern extent. Samples were collected at 5-foot intervals in this boring from ground surface until groundwater was encountered.

Hand-auger samples were collected from 0 to 1 foot bgs at two locations at Site 2 (2HA-5 and 2HA-10). These samples were collected at the 2SB-5 and 2SB-10 locations depicted on Figure 4-2. The samples were analyzed for VOCs, SVOCs, pesticides, and metals using the Synthetic Precipitation Leachate Procedure (SPLP) by Method 1312 and for physical parameters. Soil samples were also collected from one monitoring well (2MW-7) installed at Site 2.

#### **4.3.3 Site 2 — Phase III Soil**

Three samples associated with Site 2 were collected and analyzed. One sample was collected adjacent to monitoring well 2MW-7. This well is near the corner of Highway 242 and Industrial Park Road near the Cedar Chemical main office. While installing monitoring well 2MW-7 during Phase II, methoxychlor was detected in concentrations as high as 280,000 parts per billion (ppb) from 5 to 10 feet bgs. However, samples collected during the Phase I investigation of Site 2 indicated that the methoxychlor contamination is confined to the



boundaries of the former waste ponds. Well 2MW-7 is approximately 300 feet from the former waste ponds, outside the fenced perimeter of the plant. Given the remote location away from the source, this detection of methoxychlor was assumed to represent an isolated, confined anomaly. During the third phase of the investigation, a soil boring was completed near the original detection to test this assumption. One soil sample, 2SB-14 (8 -10'), was collected adjacent to well 2MW-7 to confirm the presence of methoxychlor in soil detected during the installation of this well. The sample was analyzed for SVOCs and pesticides.

The remaining Site 2 samples were collected approximately 100 feet northwest of monitoring well 2MW-3. Parallel, linear patches of stressed vegetation have been observed across Site 2 and extending beyond the suspected boundaries of the former waste ponds. One Phase III soil boring (2SB-15) was installed and sampled within one of these areas of stressed vegetation. Samples 2SB-15 (0-2'), and 2SB-15 (8-10') were collected from this boring to determine if the stressed vegetation outside the fenced area results from Site 2 contaminants. These samples were analyzed for SVOCs and pesticides.

#### **4.3.4 Site 2 — Phase I Groundwater**

Three groundwater monitoring wells were installed around the periphery of the treatment ponds at Site 2. Initially, each well was intended to be screened in the alluvial aquifer at an estimated depth of 35 feet. Again, as with Site 1, a perched zone was encountered at approximately 12 feet at two of the three proposed well locations. Two shallow, Type II wells (2MW-1 and 2MW-2) were installed along the east and west boundaries of the site in the perched aquifer. No perched zone was encountered at the location for well 2MW-3. The remaining wells, 2MW-4 and 2MW-5, were completed as Type III wells and screened in the alluvial aquifer to depths of 31 and 30 feet, respectively (all boring logs are included in Appendix A).

The three wells were sampled for VOCs, SVOCs, pesticides, metals, ammonia, bicarbonate, chloride, fluoride, sulfate, nitrate, and cyanide. Monitoring wells 2MW-1 and 2MW-2 exhibited



very slow recharge and were sampled for only some of the selected parameters due to insufficient sample volume following purging. Well 2MW-1 was sampled for VOC and pesticide analysis, and 2MW-2 was sampled for VOCs, SVOCs, pesticides, and metals analyses. Figure 4-2 depicts the Site 2 boring and monitoring well locations.

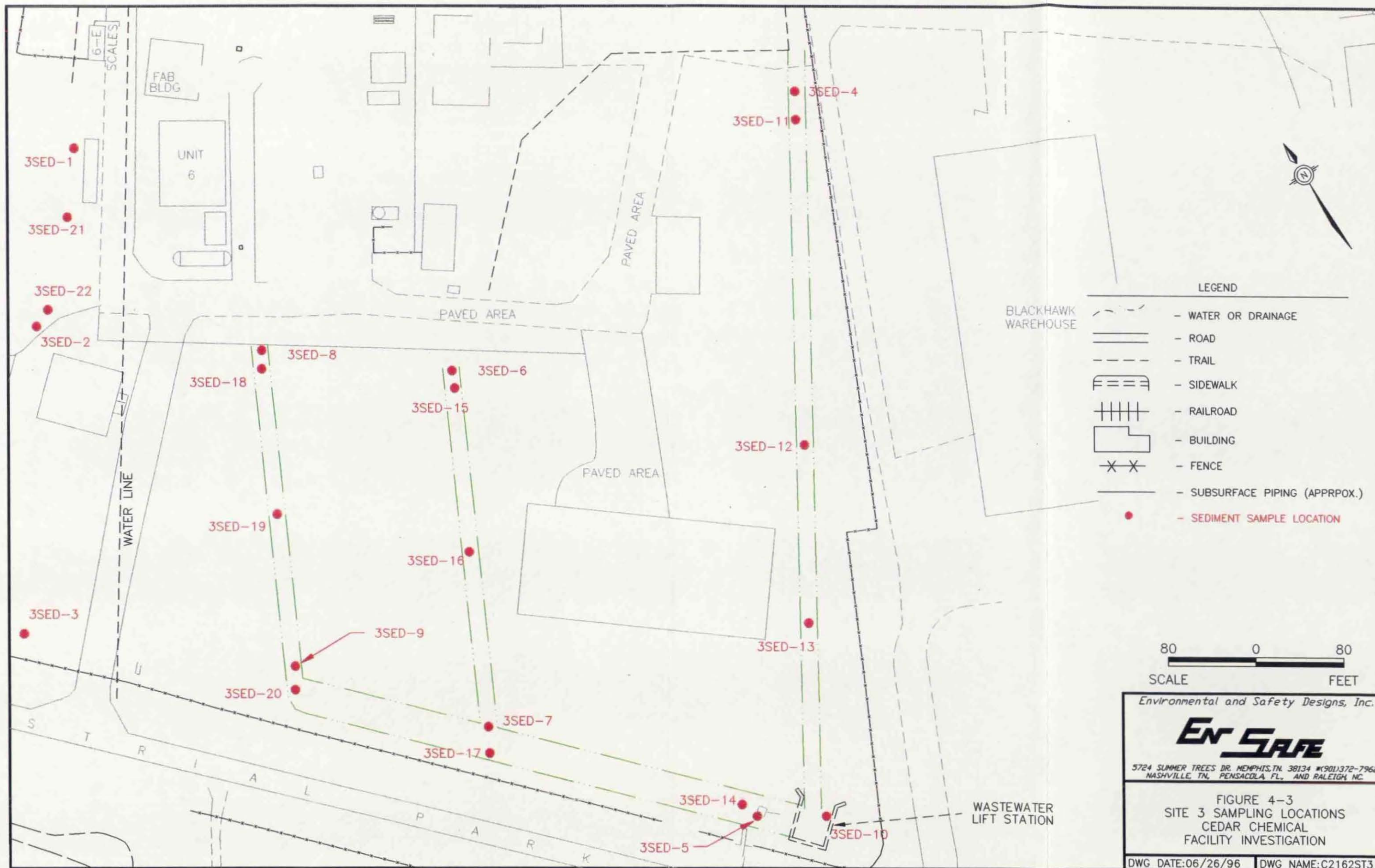
#### **4.3.5 Site 2 — Phase II Groundwater**

In addition to the five monitoring wells installed during Phase I, two monitoring wells were installed at the southwestern corner of the property boundary near the intersection of Highway 242 and Industrial Park Road. The first new well, 2MW-6, was installed as a shallow well screening the upper 10 feet of the alluvial aquifer. The second well, 2MW-7, was installed as a deep well near the base of the alluvial aquifer. These wells were placed near the corner of the property to investigate possible offsite migration of Site 2 contamination detected during the Phase I sampling. The surface casing for well 2MW-6 was installed to 24 feet and pushed 0.5 foot into the clay before grouting. The well was set through the surface casing and screened between 31 and 41 feet. The surface casing for well 2MW-7 was installed to 25 feet and pushed 0.5 foot into clay before grouting. The well was set through the casing and screened between 135 and 145 feet. Wells 2MW-3, 2MW-4 and 2MW-5 at Site 2 were sampled and analyzed for VOCs, SVOCs, lead, and arsenic during Phase II. Figure 4-2 displays the locations of the Site 2 wells and borings.

#### **4.4 Site 3**

Site 3, shown in Figure 4-3, includes two SWMUs which constitute the storm water drainage system for the facility. All storm water runoff at the facility is collected in four storm water ditches (SWMU 59) which flow through the interior of the property to the southwest. These ditches all drain into a larger storm water ditch adjacent to Industrial Park Road. This ditch flows south into the storm water sump (SWMU 60), formerly the storm water pond. The contents of the sump are periodically pumped into the wastewater treatment system directly across Industrial Park Road.







The FI work plan required collecting surface soil or sediment samples from the drainage ditches associated with Site 3. The existing monitoring wells were considered adequate for groundwater characterization at the site; therefore, no additional wells were installed during Phases I, II, or III of the FI.

#### **4.4.1 Site 3 — Phase I Soil**

Ten locations (3SED-1 through 3SED-10) were sampled with a stainless-steel hand auger or petite ponar grab sampler to detect any surface soil and sediment contamination. Nine of the 10 locations were within the storm water ditches. The tenth location was near the former storm water retention pond. The ditches were under reconstruction during sampling and the storm water retention pond was being filled to allow construction of the new sump. Therefore, a sample could not be collected from pond sediment. In response, location 3SED-10 was sampled as close to the former storm water pond as was accessible. The samples were analyzed for VOCs, SVOCs, pesticides, and metals to determine if the storm water runoff had impacted the ditches.

#### **4.4.2 Site 3 — Phase II Soil**

Elevated concentrations of metals and pesticides were detected in the sediment samples collected during Phase I. Therefore, additional samples were collected and analyzed for these constituents to determine if those detected in the sediments were also present in the native material at ambient or background concentrations beneath the ditch sediment. Twelve locations (3SED-11 through 3SED-23) were sampled at two intervals with a stainless-steel hand auger. The first interval consisted of surface sediment and the second was from the top 1 foot of native materials; the depth to native materials varied across the site. In addition to the 12 hand-auger samples, one lithologic boring was installed at Site 3 to aid in mapping the clay aquitard. Heavy yellow staining was observed while collecting lithologic samples from 3 to 7 feet, so three soil samples were collected from this boring for SVOC



analysis. All soil samples were collected following the procedure described in Section 3.1. Figure 4-3 locates the sampling locations at Site 3. Lithologic boring data can be found in Appendix A.

#### **4.4.3 Site 3 — Phase III Soil**

During the third phase, one boring (3SB-1) was installed and sampled 25 feet northwest of lithologic boring 3LB-6 to assess the vertical migration of the dinoseb detected in the Phase II samples. Boring 3-SB1 was sampled continuously until soil staining was no longer visible. Two samples were submitted for chemical analysis: a sample from the interval with the heaviest yellow staining, 3SB-1 (4-6'), and a sample from the deepest interval where staining was no longer visible, 3SB-1 (10-12').

#### **4.5 Site 4 (SWMUs 3 and 74)**

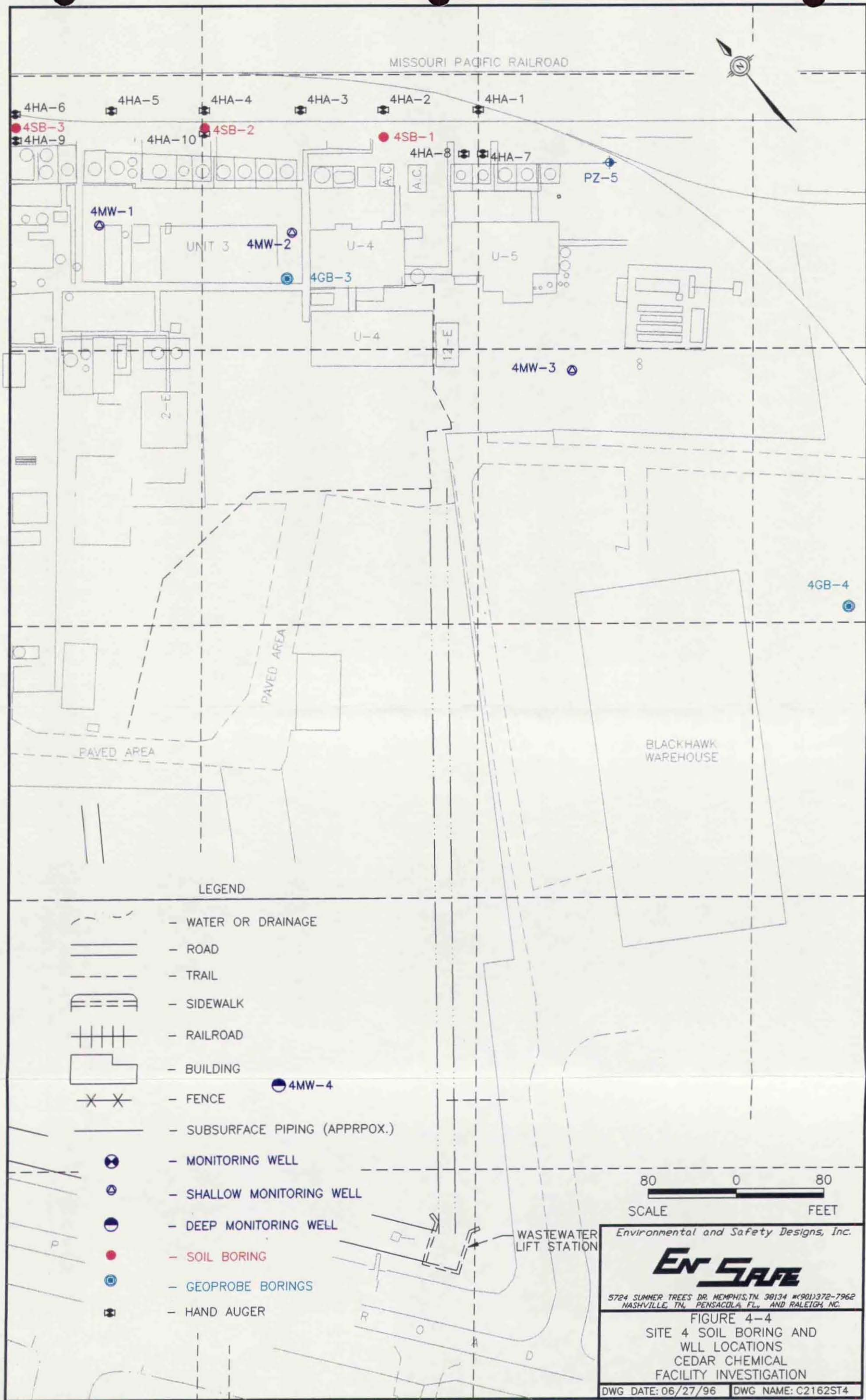
Site 4 includes two SWMUs, the railroad loading/unloading area (SWMU 74) and an abandoned railroad loading and unloading sump (SWMU 3). Both SWMUs are in an area between the railroad spur and the main tank farm where raw materials and final products are transferred between the tank farm and railroad cars. Staining in this area indicated that releases may have occurred during past transfer operations.

The work plan called for collecting and analyzing soil samples from six locations along the rail spur and two locations on either side of the abandoned sump. Two groundwater monitoring wells were also proposed for this site to determine if the reported releases had impacted groundwater at Site 4. Site 4 sampling locations are shown in Figure 4-4.

##### **4.5.1 Site 4 — Phase I Soil**

Six locations (4HA-1 through 4HA-6) were sampled in a line parallel to the rail spur along the northern property boundary. Two samples were collected from each sampling location with a stainless-steel hand auger at intervals of 0 to 12 inches and 12 to 24 inches bgs. The sample collection method for hand augers is described in Section 3.1.1. Six samples were collected







from two sampling locations (4HA-7 and 4HA-8) adjacent to the abandoned sump. The sump was approximately 3 to 4 feet deep when in operation; therefore, the two hand-auger borings were advanced to approximately 5 feet bgs before samples were collected. This ensured that the native soil from beneath the sump bottom was sampled.

Samples were collected at intervals of 5 to 6 feet, 6 to 7 feet, and 7 to 8 feet. Soil samples were also collected continually at 5-foot intervals from the two monitoring wells installed at Site 4 (4MW-1 and 4MW-2). The samples were analyzed for VOCs, SVOCs, pesticides, and metals.

#### **4.5.2 Site 4 — Phase II Soil**

Seven locations were sampled at Site 4 during Phase II. The work plan called for the completion of three soil borings (4GB-1, 4GB-2, and 4GB-3) beside the railroad at the northern boundary. Because of access problems due to overhead structures along the rail spur, these borings were installed with a Geoprobe rig instead of a larger drilling rig. Additionally, two soil samples were collected along the railroad tracks using a hand auger. The hand-auger samples were collected below the gravel layer in the native material and analyzed for VOCs, SVOCs, and pesticides by SPLP analyses. These sample locations were selected based on Phase I data to determine the leachability of the detected compounds in heavily and moderately contaminated areas. Figure 4-4 locates all soil borings at Site 4.

Soil samples were also collected from the two monitoring wells installed at Site 4 (4MW-3 and 4MW-4) continuously at 5-foot intervals. The soil samples collected from these well borings were analyzed for VOCs, SVOCs, and pesticides.

An air sample was collected from monitoring well 4MW-1 to determine the nature of the gas blowing from the well.



#### **4.5.3 Site 4 — Phase I Groundwater**

Two Type III groundwater monitoring wells were installed at Site 4 to determine if past plant operations had impacted the groundwater beneath the site. Well 4MW-1 was installed in the Propanil unit U-1 expansion area and 4MW-2 was installed in the roadway between the Unit 3 expansion area and the U-4 Nitration unit. Both wells were completed with flush-mount surface pads. The surface casings for the two wells (4MW-1 and 4MW-2) were set into the clay confining unit above the alluvial aquifer at a depth of 20 feet and pressed 1 foot into the clay. The wells were set through the casing and screened in the confined alluvial aquifer from 27 to 37 feet. Figure 4-4 depicts the sample and well locations of Site 4.

Visual and olfactory signs of contamination were observed while installing these wells. A strong odor, similar to gasoline, was noticed while installing the surface casing for well 4MW-1. On September 17, 1993, after the surface casing was installed and the grout had cured overnight, the borehole was advanced through the surface casing to install the well. Once the clay semiconfining unit was penetrated, gas was observed blowing out of the augers. The explosimeter alarm sounded, and organic vapor concentrations of 144 parts per million (ppm) were measured with a PID above the augers. Drilling operations ceased and the boring was grouted up into the semiconfining unit to prevent the gas from blowing out of the borehole. On September 22, 1993, the grout was drilled out of the hole and Draeger tube samples of the gas were collected by an EnSafe Health and Safety Specialist. Toluene and xylene concentrations were too high to be accurately quantified by the Draeger tubes. Benzene concentrations were approximately 10 ppm. The area surrounding the borehole was secured with caution tape and the boring was allowed to vent until the gas pressure had dropped enough to install the well.

Well 4MW-2 was installed approximately 160 feet southwest of well 4MW-1. No gas was observed in this well boring. However, the soil core retrieved from the alluvial sands was saturated with yellow to orange, slightly foamy water.



#### **4.5.4 Site 4 — Phase II Groundwater**

Two additional Type III groundwater monitoring wells were installed during Phase II at Site 4. Well 4MW-3 was installed near the new hydrogen tube trailer area and 4MW-4 was installed south of the drum storage warehouse and loading dock area. Both wells were completed above ground. The surface casing for 4MW-3 was set and pressed into the clay confining unit at 23.5 feet bgs, and the well screen was set from 32.5 to 46.5 feet bgs. The surface casing for 4MW-4 was set at 29 feet and pressed 1 foot into the clay. The well was set through the casing and screened between 140 to 150 feet bgs. The annulus between the borehole and the casing was grouted to ground surface and allowed to cure before the well was installed. Figure 4-4 depicts the sample and well locations of Site 4.

One Geoprobe boring (4GB-3) was installed to determine the vertical extent of groundwater contamination near shallow well 4MW-2. The Geoprobe boring was advanced below the screened interval of well 4MW-2, to 50 feet bgs where the first groundwater sample was collected. Sampling continued at 15-foot intervals to a maximum of 95 feet bgs. Groundwater samples were analyzed for VOCs and SVOCs.

#### **4.6 Site 5**

This unit is a concrete vault with walls of poured concrete, a sub-floor of gravel, sand, and possibly cement, and a concrete cap which forms the floor of the warehouse onsite. In addition to fill sand and gravel, the vault contains approximately 250 drums of solidified, low-grade herbicide which did not meet product specifications. It is believed that the drums were placed in the vault in early 1976.

The potential for releases from this unit to the soil, groundwater, and subsurface gas is unknown because the materials and design used in building the vault are largely unknown. The potential for releases from this unit to the air and surface waters is unlikely because it is below grade.



#### **Site 5 — Phase I Soil Sampling**

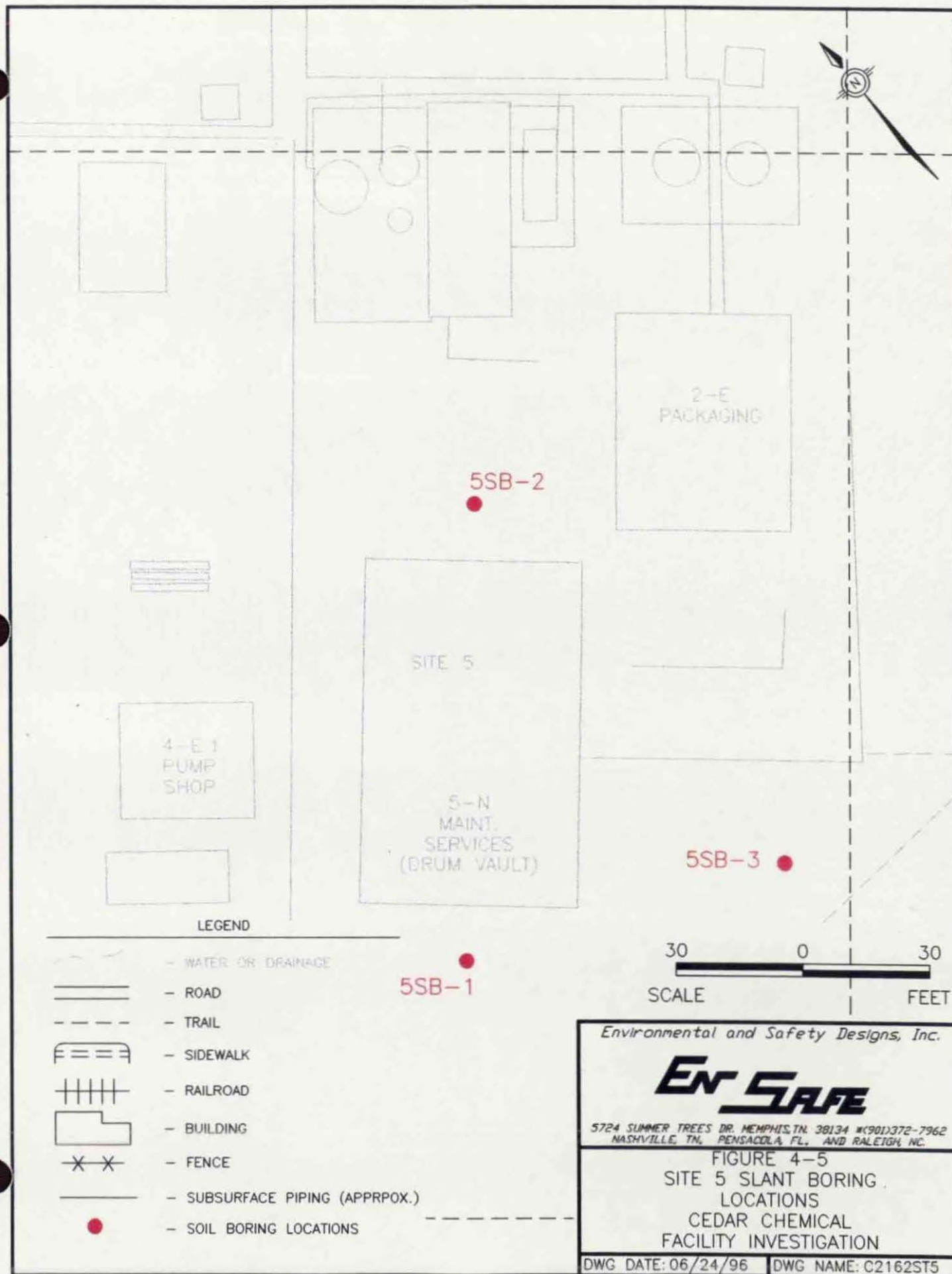
Three slant borings were proposed to be installed and sampled around the building. The boring locations proposed in the work plan were changed in the field due to complications caused by overhead obstructions on the west side of the warehouse. Figure 4-5 shows the actual boring locations. To collect soil samples from beneath the floor of the warehouse without drilling through the drum vault, slant borings were installed along the building perimeter. The borings were positioned 11 feet from the building. The augers were advanced 16 feet at a 45° angle before the first sample was collected. After advancing the augers 16 feet, the vertical depth of the auger bit was 11 feet beneath the exterior wall of the warehouse. Samples were collected from 16 to 18 feet and from 21 to 23 feet (11 vertical feet and 16 vertical feet bgs). Figure 4-6 provides a graphical representation of the sampling procedure used at Site 5.

Dinoseb was detected in boring 5SB-2 samples only. Due to the proximity of this boring relative to Site 9, it was determined that the Dinoseb was not associated with Site 5 and no Phase II sampling was recommended or conducted.

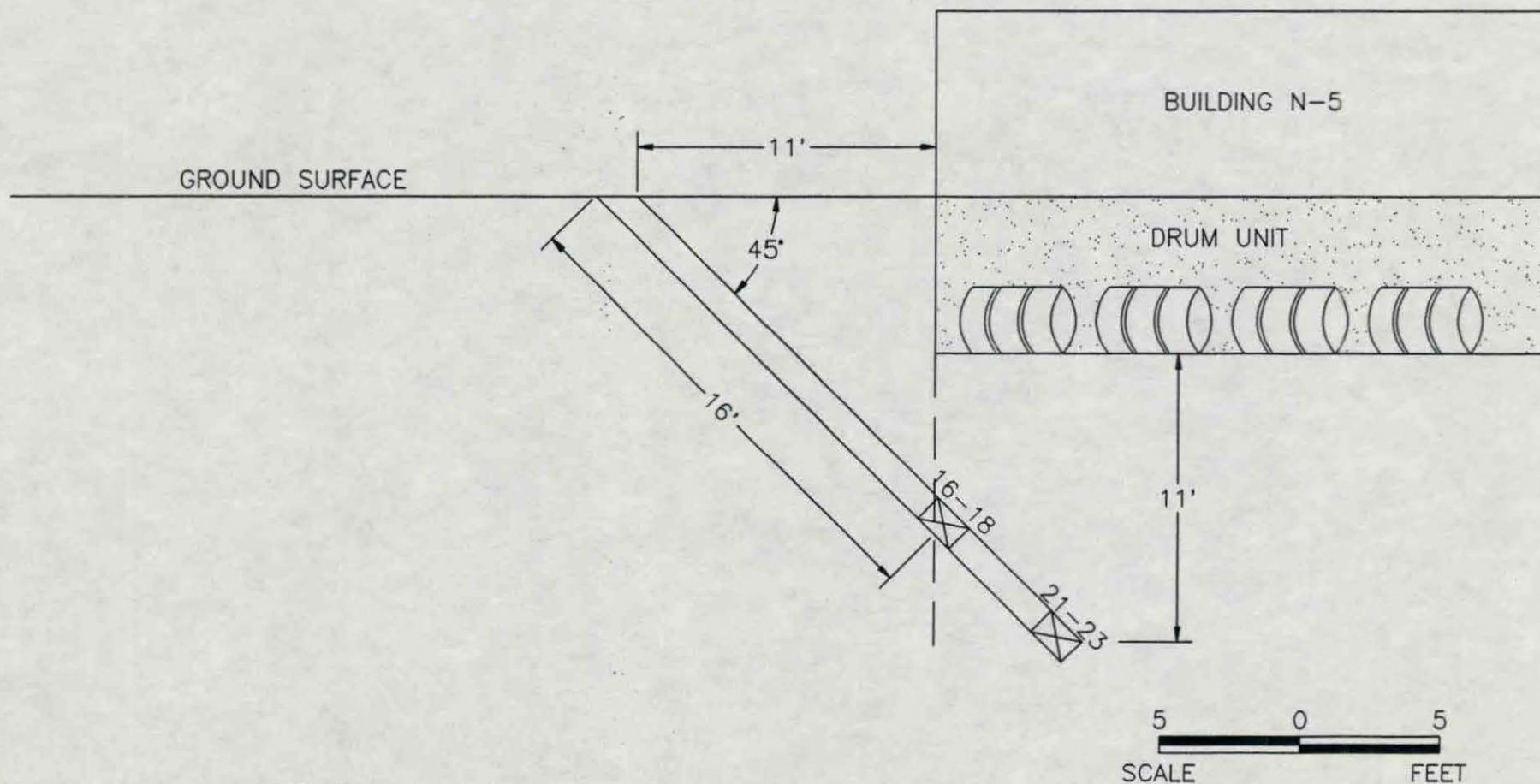
#### **4.7 Site 6**

This site includes several areas of the plant where yellow staining is visible, particularly after rain, indicating the presence of Dinoseb. The staining appears to be dispersed across the nonproduction area of Site 6 with some areas more heavily stained than others. The Phase I and Phase II sampling locations are shown in Figure 4-7.







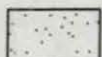


# LEGEND

16-18



- SAMPLE INTERVAL



- SAND

Environmental and Safety Designs, Inc.

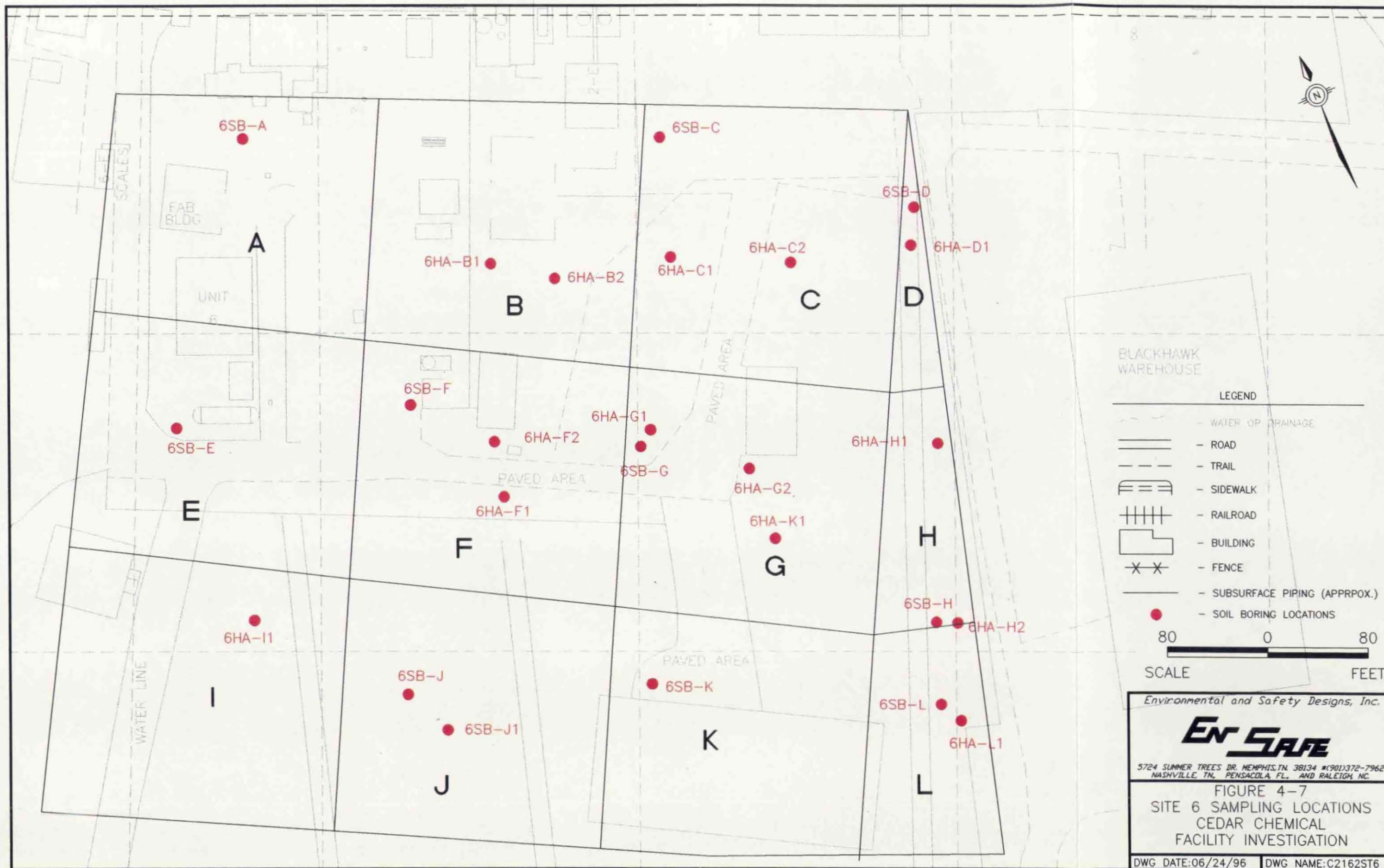
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FIGURE 4-6  
SLANT BORING SCHEMATIC  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/24/96 | DWG NAME: C2162SBS







An Interim Measures sampling event was conducted by EnSafe in April 1993 prior to the initiation of the Phase I sampling activities. These samples were collected from Site 6 in an area that is now the new employee parking lot. The borings and samples corresponding to the Interim Measures sampling event were designated as "IM." The data for these samples are provided in Section 5.7.

#### **4.7.1 Site 6 — Phase I Soil**

Site 6 was divided into twelve 200-foot by 200-foot grid squares. One soil boring was installed at the center of each grid square. Ten samples were collected from the sampling grid (Figure 4-7). As seen in Figure 4-7, no samples were collected from grids B and I. The soil borings installed for Site 9 overlap Site 6 and provide sufficient soil data coverage for grid B. Borings installed by EnSafe in April 1993 provide adequate soil data for grid I. Two soil samples were collected continuously from each boring at 5-foot intervals to a terminal depth of 10 feet. The broad coverage provided by this sampling scheme will help delineate the vertical and horizontal extent of contamination in Site 6 soil.

#### **4.7.2 Site 6 — Phase II Soil**

Fifteen hand-auger samples were collected at Site 6 based on the data from the Phase I sampling. These samples and the data were collected specifically for conducting a risk assessment and were analyzed for pesticides and SVOCs. Shallow samples were collected from the surface to a depth of 12 inches in strategic locations where contamination was suspected or confirmed. Sample locations for Site 6 are presented in Figure 4-7.

#### **4.8 Site 8 (Area of Concern 3)**

This area of concern (AOC) is a ditch on the south side of the wastewater treatment ponds. In the past the API Separator would periodically overflow and wastewater destined for the treatment ponds would flow down the back side of the equalization pond berm in the industrial park ditch to the White River. To remediate this problem, the separator and pad were cleaned and a gutter



was installed in February 1992. The gutter was designed to divert all overflow into the equalization pond. The contaminated soil in the ditch was also removed, placed in drums, and sent to the Chemical Waste Management Subtitle C landfill in Carlyss, Louisiana; however, no confirmatory sampling of the ditch was performed. All storm water is currently discharged to NPDES Outfall No. 002 via the treatment ponds.

#### **4.8.1 Site 8 — Phase I Soil Sampling**

The soil of the Site 8 ditch was assessed by collecting four soil and/or sediment samples from the bottom of the ditch (8HA-6, 8HA-7, 8HA-8, 8HA-9). The first sample was collected 50 feet north of the API separator and sampling continued in 50-foot increments southward. A sample was collected from the upper 1 foot of soil with a stainless-steel hand auger at each location. Figure 4-8 depicts the sampling locations for Site 8. No additional sampling was conducted at this site during the subsequent phases of the investigation.

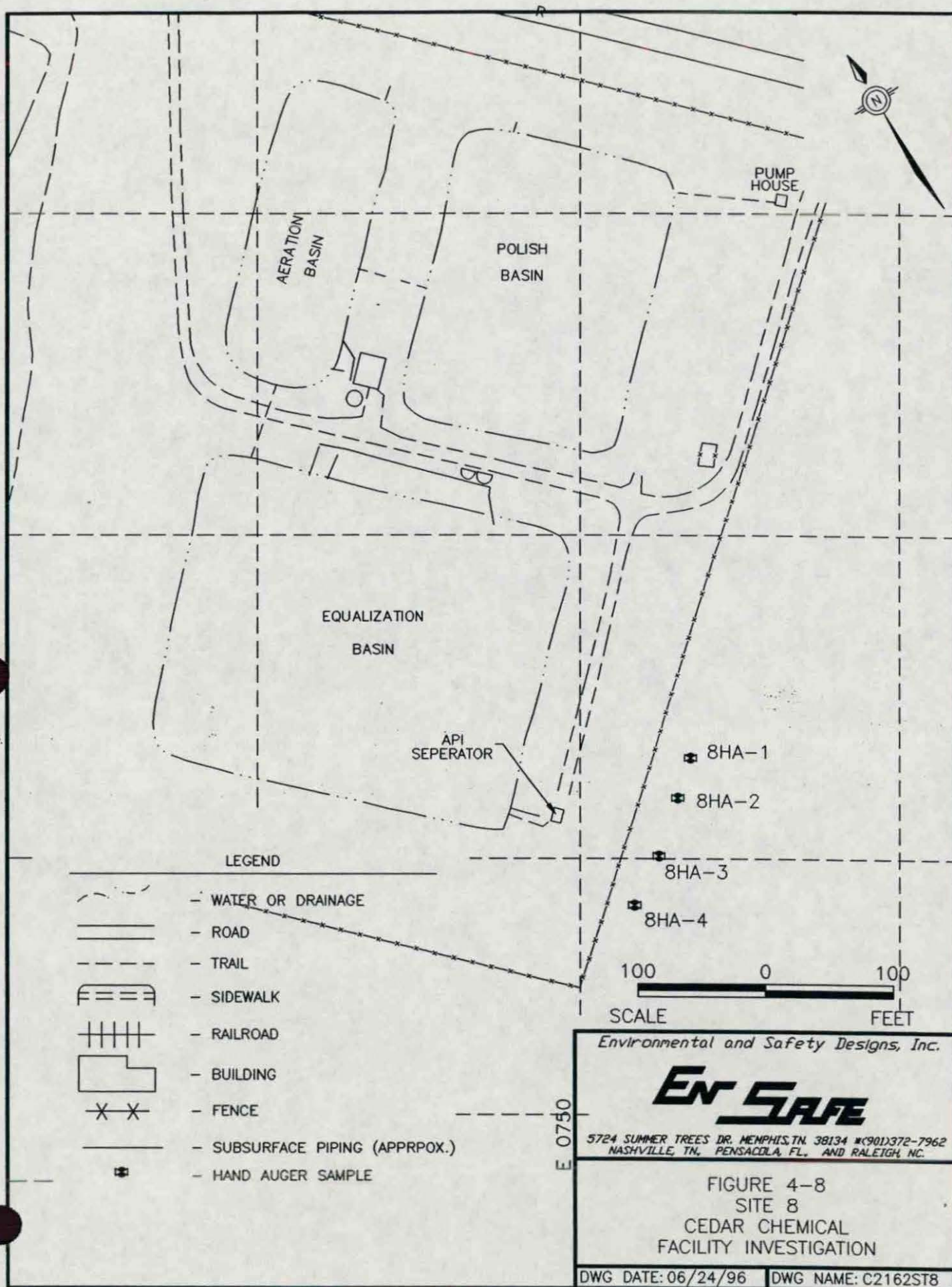
#### **4.9 Site 9**

Site 9 consists of three suspected abandoned ponds in the area between the Dichloroaniline unit and the maintenance services building (Site 5). The ponds were reportedly shallow, unlined basins used to dispose of off-specification dinoseb. The ponds are no longer used and have since been backfilled. Buildings have been constructed over the ponds and some areas have been paved. Unpaved areas in Site 9 exhibit heavy yellow staining on the surface soil. Although not addressed in the work plan, an indefinite number of soil borings were proposed to confirm the existence of the ponds. Once located, enough additional borings were planned to delineate their horizontal and vertical boundaries. All sampling locations and wells at Site 9 are shown in Figure 4-9.

##### **4.9.1 Site 9 — Phase I Soil**

Nineteen soil borings (9SB-1 through 9SB-19) were installed at the site to locate and delineate the ponds. Analytical samples were collected from each boring at 5-foot intervals. Each soil



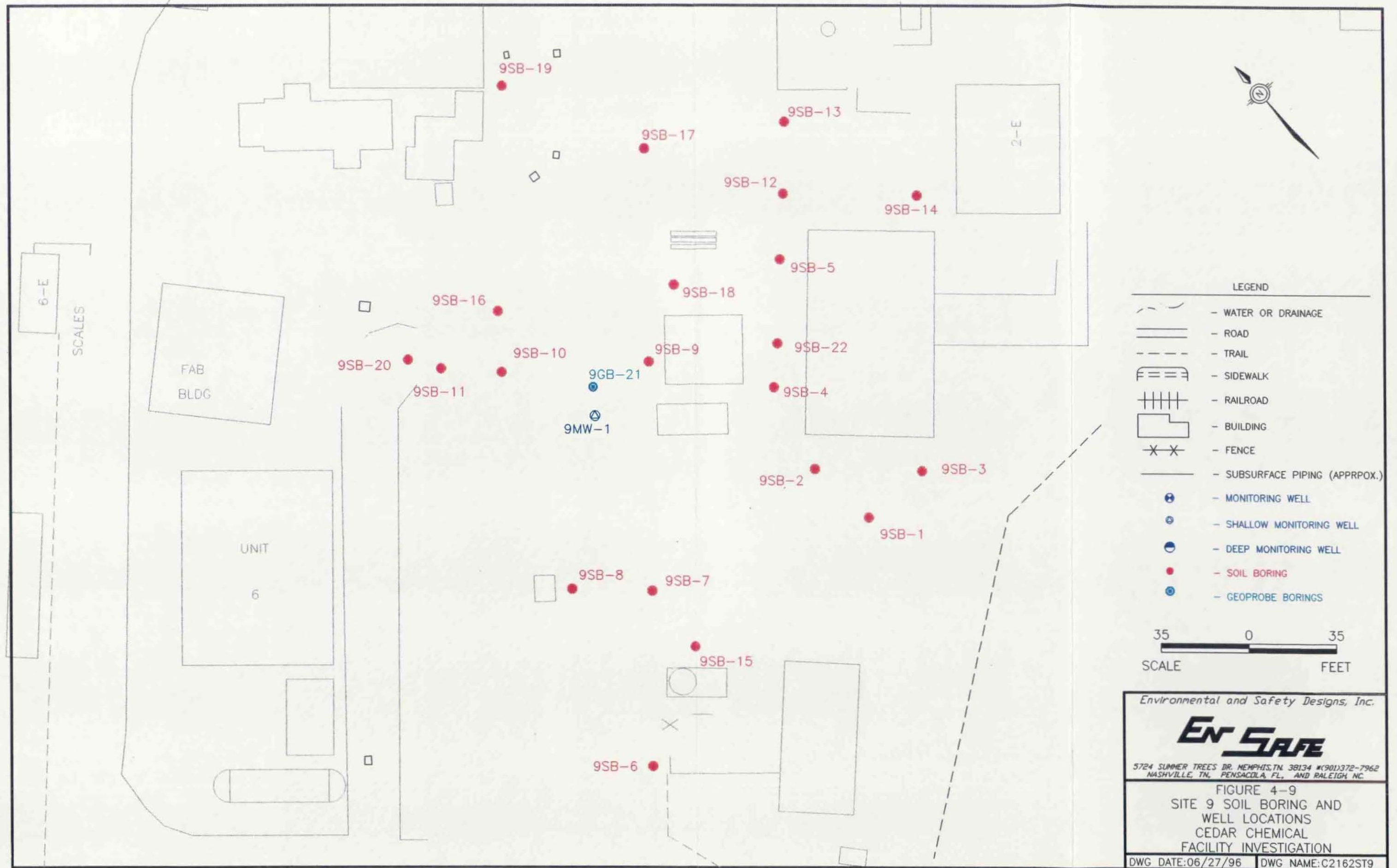


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boring was sampled to a minimum of 10 feet and terminated once a stain-free sample was retrieved. Two split samples were containerized immediately from each 5-foot interval in all soil borings. One split sample from each sampling interval was submitted to the onsite Cedar laboratory for Dinoseb analysis with 24-hour turnaround time schedule for the results. Additional sample volume from each boring was placed in resealable plastic bags and archived in a refrigerator in the EnSafe site trailer. Once the analytical results from the Cedar laboratory were received, all archived split samples were submitted to I.T. Analytical Services in Export, Pennsylvania for SVOC analysis. The sample intervals with the lowest and highest Dinoseb concentrations, as reported by Cedar Chemicals Lab, were retrieved from the refrigerator and submitted to I.T. for VOC, SVOC, pesticide, and RCRA metals analyses.

#### **4.9.2 Site 9 — Phase II Soil**

Three Geoprobe soil borings (9SB-20, 9SB-21, and 9SB-22) were collected in areas which exhibited the highest Dinoseb contamination as delineated from analysis of samples from Phase I soil borings. Sample collection began at 10 feet and continued at 2-foot intervals until groundwater was encountered. Analytical samples from each boring were collected and submitted from three intervals; the first was collected at 10 feet, the second was collected at the bottom of the boring immediately above groundwater, and the third was collected from the sample with the highest PID reading screened from the intermediate samples. Each sample was analyzed for VOCs and SVOCs.

#### **4.9.3 Site 9 — Phase II Groundwater**

One Type III monitoring well was installed during Phase II at Site 9 to determine whether the dinoseb detected in the site soil had migrated to groundwater. Well number 9MW-1 was installed just south of the boiler room adjacent to Shipping and Receiving. Well 9MW-1 was installed with a flush-mounted surface completion. The surface casing was set at 25.5 feet and the well was screened between 31 to 41 feet bgs.



In addition to the well, one Geoprobe water sample was also collected at Site 9. The Geoprobe boring (9SB-21) was placed a few feet north of 9MW-1 to determine the vertical extent of groundwater contamination at this site. Groundwater samples were collected at four different intervals. The first sampling interval was at 45 feet, the second at 60 feet, the third at 75 feet, and the fourth at 90 feet. All Site 9 groundwater samples were analyzed for VOCs and SVOCs.

#### **4.10 Dichloroethane Source Area Investigation**

As part of Phase III, Cedar Chemical was tasked with determining the source of the 1,2-dichloroethane present in groundwater. Based on the concentration gradient of the plume, determined after the completion of Phase II, it was concluded that the likely source area is in the vicinity of the production units on the northeast side of the plant. During interviews with Cedar employees, it was learned that there was formerly a tile wastewater discharge pipe that ran from Unit 5 to the wastewater treatment ponds, crossing the path of the suspected source area. Reportedly, the tile pipe frequently leaked and had to be replaced. As the pipe was being decommissioned, an unknown quantity of a liquid chemical was observed in the pipe and pipe trench.

The potential source area for 1,2-dichloroethane was investigated by establishing a grid across the suspected source area at the eastern end of the production area. A soil boring was installed and sampled at or near to each grid intersect point using the Geoprobe rig. Grid squares were approximately 75 feet by 75 feet. Samples for chemical analysis were collected continuously at 2-foot intervals to the surface of the alluvial clay, approximately 30 feet bgs. The boring locations are depicted in Figure 4-10.

Sample analysis was conducted in the field using a portable GC. Nineteen split confirmation samples were submitted to the contract laboratory as a quality assurance check to confirm the results of the field analysis. In addition, samples were submitted if they exhibited obvious olfactory or visual signs of contamination that were not analytically confirmed by the field GC laboratory. A map depicting all site sampling locations is provided in Appendix E.



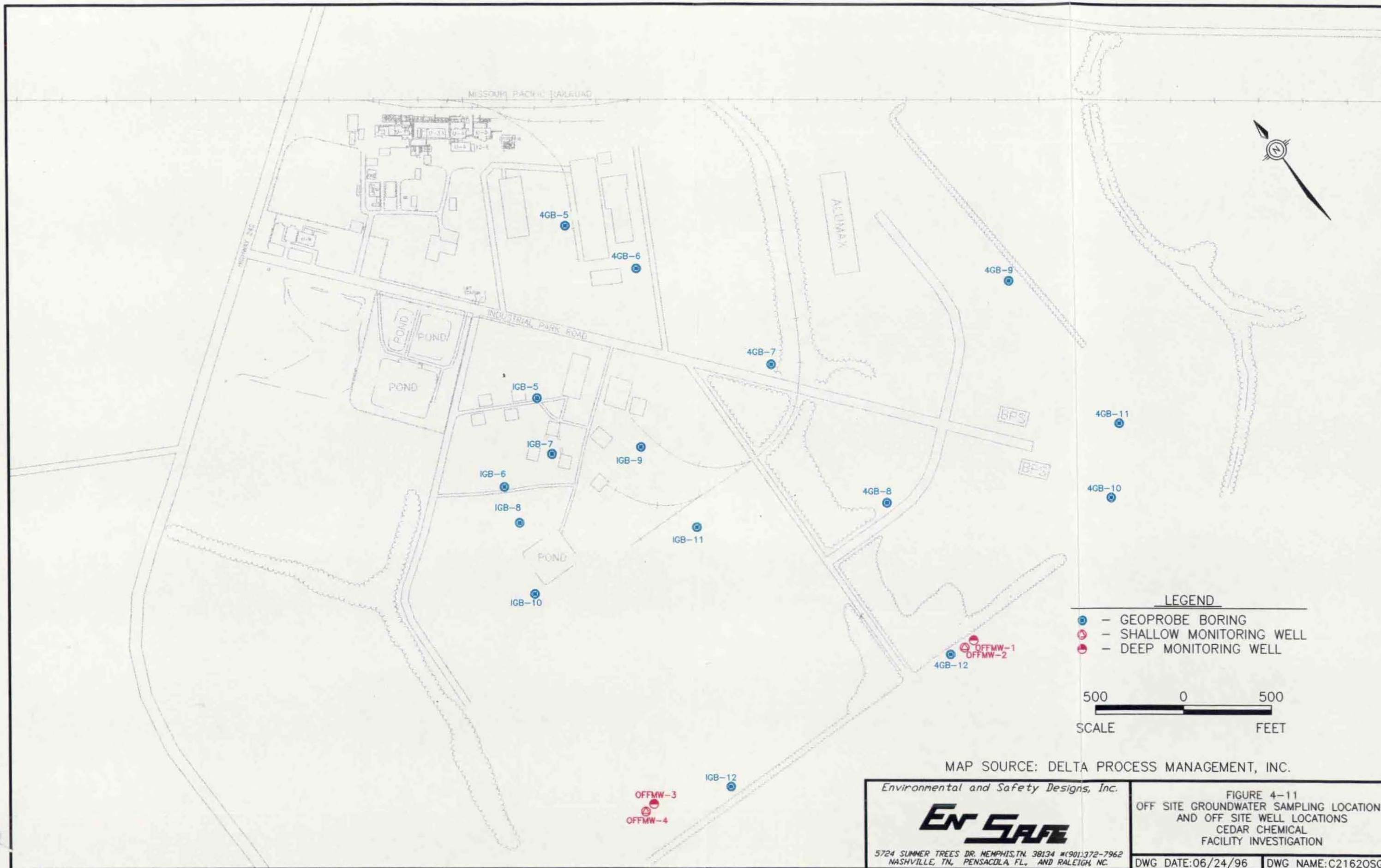
in the field that exhibited no contamination were split and submitted to the contract laboratory for VOC analysis to confirm the results of the field GC.

#### **4.11.2 Offsite Monitoring Wells**

Two deep well pairs were installed, using mud rotary drilling techniques, approximately three-quarters of a mile hydraulically downgradient of the site at locations where both the screening and confirmation samples were nondetect for 1,2-dichloroethane. Each deep well pair consists of one well screening an 18-foot section of the alluvial aquifer at the Jackson Clay surface, and a shallower well screening a 20-foot section of the alluvial aquifer approximately 9 feet above the deeper well screen. Installing well pairs allows a large portion of the aquifer to be screened, while maintaining the ability to determine whether any contaminant is migrating in the middle or lower portions of the aquifer. The ability to make this distinction is important since the aquifer has varying hydraulic conductivities and corresponding flow rates. In addition, 1,2-dichloroethane could be a multiphase contaminant migrating as a dissolved aqueous phase constituent in the middle portion of the aquifer and/or as a DNAPL across the Jackson Clay surface. One offsite well pair (OFFMW-1 and OFFMW-2) was installed on agricultural land owned by Mr. Harry Stephens. This well pair is on the southern side of a bermed ditch separating BPS, Inc. property and the Stephens property. The other offsite well pair (OFFMW-3 and OFFMW-4) is near the southern boundary of the Norac property, which is currently leased to Mr. Harry Stephens for agricultural use. Figure 4-11 presents the offsite well locations.

Each deep well is completed with a 20-foot screen. In the deeper wells (OFFMW-1 and OFFMW-3) each boring was terminated and the well installed after penetrating 7 feet into the Jackson Clay. At these depths, the screens extend 2 feet into the Jackson Clay, followed by 5-foot sumps to total depth to contain any DNAPL that may flow into the well. The remaining portion of the well screen extends 18 feet above the surface of the Jackson Clay, screening the lower coarse sands and gravel of the alluvial section. The shallow wells are screened from







approximately 9 feet above the top of the deeper well screens to assess an overlying interval containing less gravel and more sand in the aquifer matrix.

In OFFMW-1 the Jackson Clay was encountered at a depth of 137 feet bgs. The total depth of this well is 143.5 feet. The screened interval extends from 138.5 to 118.5 feet. The shallower well in this pair (OFFMW-2) was screened from 110 to 90 feet.

The Jackson Clay surface was encountered at 126 feet in OFFMW-3. The well was completed at a depth of 133 feet with a screened interval of 128 feet to 108 feet. The shallower well in this pair (OFFMW-4) was completed at a depth of 99 feet and screened from 99 to 79 feet bgs. Once installation and development was completed, both well pairs were sampled for VOC, SVOC, pesticide, metals, total organic carbon (TOC), and total organic halides (TOX) analyses.

#### **4.12 Baseline Groundwater Sampling Event**

All site wells except well 9MW-1, 2MW-1, 2MW-2, and EMW-6C were sampled during Phase III to establish baseline groundwater conditions prior to the implementation of quarterly groundwater monitoring. Well 9MW-1 was inaccessible during Phase III due to construction, and wells 2MW-1, 2MW-2 and EMW-6C were dry. All wells were sampled for TOX and TOC. Three wells (4MW-2, EMW-7, and 2MW-6) were sampled for TOX, TOC, VOC, and SVOC analyses. Data from these three wells are presented in Section 6 for comparison to data from previous sampling events. For more detail regarding TOX and TOC analyses, please refer to the quarterly groundwater monitoring reports.

Due to anomalies in the static water level data, no water level measurements or potentiometric surface maps have been included for the baseline groundwater sampling event. However, a potentiometric surface map generated from groundwater elevations from the first-quarter groundwater sampling event has been provided in Section 6 of this report.







## **5.0 SOIL CONTAMINATION**

This section presents the results of the chemical analyses conducted on the soil samples collected during Phases I, II, and III of the FI. The soil contaminants detected during each phase are presented and discussed in the following sections. A complete set of laboratory results are presented in the laboratory reports in Appendix D.

### **5.1 Background Soil Samples**

During the Phase I, three background soil samples collected from soybean fields adjacent to the Cedar Chemical facility were analyzed for VOCs, SVOCs, pesticides, and metals. BGHA-1 was collected in the field northeast of the Unit 5 and BGHA-2 was collected in the field west of Site 2. BGHA-3 was collected in the field southwest of the Site 1 equalization basin. Table 5-1 presents the analytical results for background soil samples. As seen in the table, the compounds 4,4'-DDT and 4,4'-DDE were detected in samples BGHA-1 and BGHA-3. Although these compounds were detected onsite, it is most likely that they represent residuals from past general application of DDT, given the widespread use of pesticides in agricultural operations.

### **5.2 Site 1 Soil Contamination**

#### **Phase I**

Four areas in Site 1 were addressed during Phase I sampling to determine if site operations had impacted surface and subsurface soil. Hand-auger boring samples were collected from 0 to 1 foot bgs at Wastewater Tank 2 and the API separator. Continuous soil samples were collected at 5-foot intervals from the monitoring well borings installed around the ponds' perimeter. A sediment sample was also collected from each of the three ponds (samples identified as 1SED-1, etc.). All soil samples collected at this site were analyzed for VOCs, SVOCs, pesticides, and metals. An isopleth map of total pesticides in soil from 0 to 5-feet bgs is provided in Figure 5-1. Isopleths for total VOCs and total SVOCs could not be produced due to too few positive results for those analyses. Table 5-2 presents the contaminants detected in the soil and sediment samples collected during the Phase I FI at Site 1.



**Table 5-1**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Background Soil Samples**

Compound	BGHA-1 (0-1')	BGHA-2 (0-1')	BGHA-3 (0-1')
<b>Volatiles (ppb)</b>			
Toluene	13	U	10
Total Xylenes	7	U	U
Acetone	U	U	1200
Methylene Chloride	6	2	7
2-Butanone	U	U	32
<b>Semivolatiles (ppb)</b>			
bis-(2-Ethylhexyl)phthalate	1	U	U
Di-n-butylphthalate	U	U	2
<b>Pesticides (ppb)</b>			
4,4'-DDT	25	U	29
4,4'-DDE	16	U	20
<b>Metals (ppm)</b>			
Lead	10.1	10.3	11.2
Arsenic	3.9	6.2	5.3
Barium	204	174	138
Chromium	13.1	U	10.7

*Note:*

U Not detected above Practical Quantitation Limits (PQLs)



Table 5-2  
Cedar Chemical  
Phase I Facility Investigation  
Site 1 Soil Data

Compound	1HA-1 (0-1')	1HA-2 (0-1')	1HA-3 (0-1')	1HA-4 (0-1')	1HA-5 (0-1')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	13
1,2-Dichloroethane	U	U	U	U	7,500
4-Methyl-2-Pentanone	U	U	U	U	92
Toluene	U	U	U	U	930
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	760
Total Xylenes	U	U	U	3	440
2-Hexanone	U	U	U	U	U
Acetone	U	U	U	U	64
Chloroform	U	U	U	U	98
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	6
2-Butanone	U	U	U	57	53
<b>Semivolatiles (ppb)</b>					
4-Methylphenol	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	260
Pyrene	U	160	U	U	U
Di-n-butyl phthalate	U	U	U	U	750
Dinoseb	9,600	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	1,500,000	U
<b>Pesticides (ppb)</b>					
Endosulfan Sulfate	U	U	U	U	4,900
Aldrin	U	22	U	U	U
beta-BHC	U	U	U	47	510
delta-BHC	U	U	U	U	2,100
4,4'-DDT	380	U	31	U	U
gamma-Chlordane	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	U	U	U	593
4,4'-DDD	110	U	U	U	U
4,4'-DDE	98	47	8	31	U
<b>Metals (ppm)</b>					
Lead	8	9	9	20	8
Arsenic	5	45	6	7	3
Silver	U	U	U	U	U
Barium	119	164	163	152	44
Cadmium	U	U	U	U	U
Chromium	11	14	13	14	9
Mercury	U	U	U	U	U

Note:

U Not detected above PQLs

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**Table 5-2**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 1 Soil Data**

Compound	1MW-1 (0-5')	1MW-1 (5-10')	1MW-2 (0-5')	1MW-2 (5-10')	1MW-3(0-5')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	U
1,2-Dichloroethane	U	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	U	U
Toluene	U	U	U	U	U
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U
Total Xylenes	U	U	U	U	U
2-Hexanone	U	U	U	U	U
Acetone	130	U	U	U	U
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	U
2-Butanone	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Methylphenol	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
Pyrene	U	U	U	U	U
Di-n-butyl phthalate	U	U	U	U	U
Dinoseb	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
beta-BHC	U	U	U	U	U
delta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	U	U	U	U
4,4'-DDD	12	U	13	U	U
4,4'-DDE	11	U	6.1	U	U
<b>Metals (ppm)</b>					
Lead	9.1	8.5	9.1	11.2	9.3
Arsenic	5.7	6.1	14	7	6.8
Silver	U	U	U	U	U
Barium	248	130	156	193	100
Cadmium	U	U	U	U	U
Chromium	12.7	14.4	10.9	15	11.3
Mercury	U	U	U	U	U

*Note:*

U Not detected above PQLs

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Table 5-2  
Cedar Chemical  
Phase I Facility Investigation  
Site 1 Soil Data

	1MW-3 (5-10')	1MW4 (0-5')	1MW-4 (5-10')	1MW-5 (0-5')	1MW-5 (5-10')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	U
1,2-Dichloroethane	U	U	U	U	U
4-Methyl-2-Pentanone	U	2	U	U	U
Toluene	U	U	U	U	U
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U
Total Xylenes	U	U	U	U	U
2-Hexanone	U	U	U	U	U
Acetone	U	U	U	U	U
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	U
2-Butanone	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Methylphenol	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
Pyrene	U	U	U	U	U
Di-n-butyl phthalate	U	U	U	U	U
Dinoseb	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
beta-BHC	U	U	U	U	U
delta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	U	U	U	U
4,4'-DDD	U	U	U	15	U
4,4'-DDE	U	U	U	11	U
<b>Metals (ppm)</b>					
Lead	9.6	7.7	7.3	8	5.9
Arsenic	8.6	3.3	6.1	5.2	4.8
Silver	U	U	U	U	U
Barium	169	271	140	108	141
Cadmium	U	U	U	U	U
Chromium	12.9	11	13.5	13.5	8.6
Mercury	U	U	U	U	U

**Notes:**

U Not detected above PQLs

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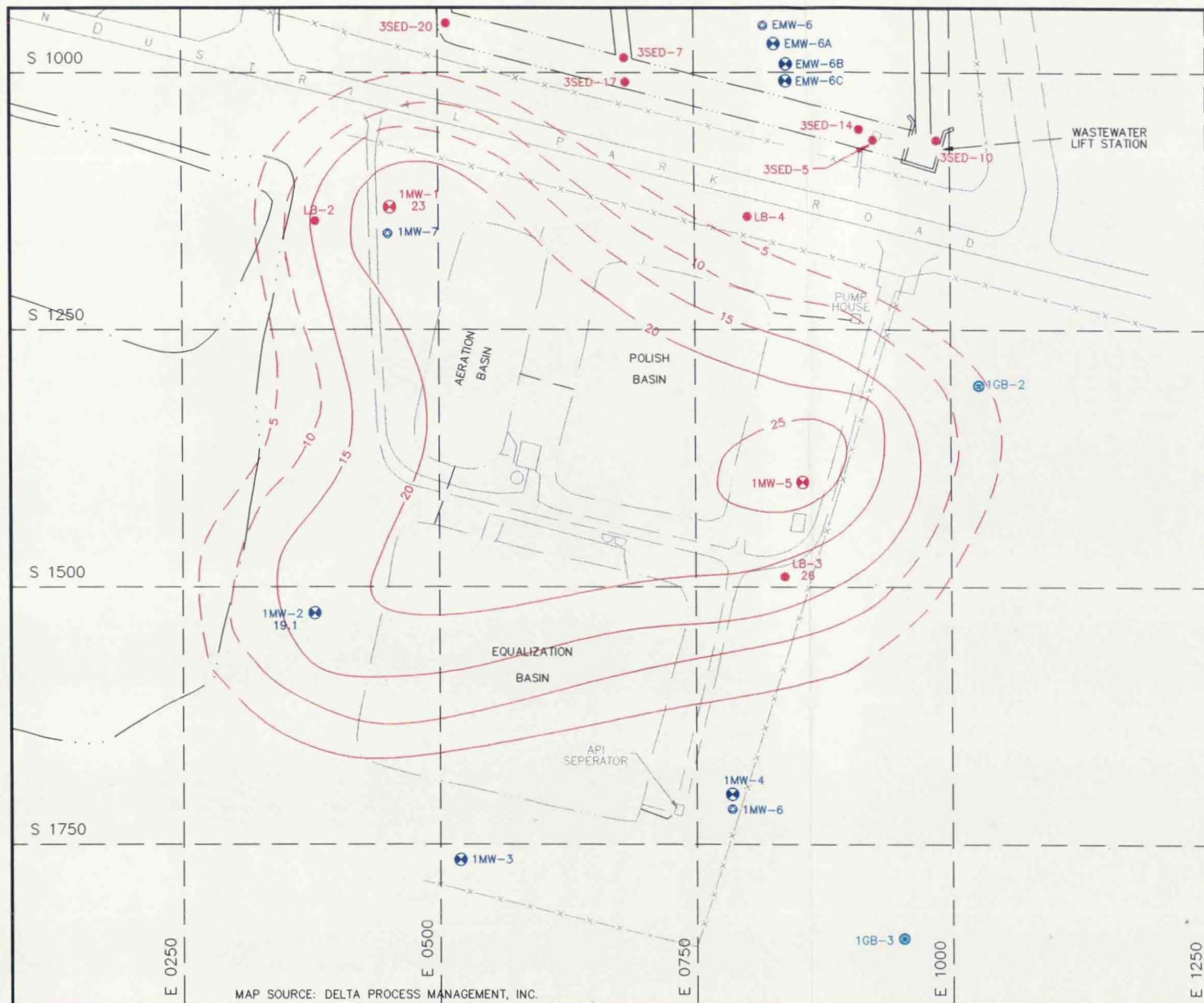
Table 5-2  
Cedar Chemical  
Phase I Facility Investigation  
Site 1 Soil Data

Compound	1MW-6 (25-30')	1SED-1	1SED-2	1SED-3
<b>Volatiles (ppb)</b>				
Ethylbenzene	U	U	U	19
1,2-Dichloroethane	210	U	U	U
4-Methyl-2-Pentanone	U	U	U	22
Toluene	U	170	U	87
Chlorobenzene	U	190	U	66
Tetrachloroethene	U	U	U	U
Total Xylenes	U	74	U	330
2-Hexanone	U	210	U	12
Acetone	54	1,200	U	280
Chloroform	U	U	U	U
Benzene	U	30	U	6
Methylene Chloride	33	U	U	U
2-Butanone	U	1,800	2	150
<b>Semivolatiles (ppb)</b>				
4-Methylphenol	U	39,000	U	U
1,2-Dichlorobenzene	U	U	U	U
Pyrene	U	U	U	U
Di-n-butyl phthalate	120	U	U	U
Dinoseb	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	13,000
3,4-Dichloroaniline	U	1,200,000	5,500	910,000
<b>Pesticides (ppb)</b>				
Endosulfan Sulfate	U	U	U	U
Aldrin	U	U	U	U
beta-BHC	U	180	U	86
delta-BHC	U	U	U	U
4,4'-DDT	U	U	U	450
gamma-Chlordane	U	300	U	U
Lindane	U	63	U	U
Dieldrin	U	U	U	U
4,4'-DDD	U	U	U	U
4,4'-DDE	U	U	U	U
<b>Metals (ppm)</b>				
Lead	9	16	14	11
Arsenic	2	61	19	123
Silver	U	U	U	1
Barium	114	59	28	69
Cadmium	0	1	U	U
Chromium	12	52	17	82
Mercury	U	3	U	U

*Notes:*

U Not detected above PQLs





Environmental and Safety Designs, Inc.

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FIGURE 5-1  
SITE 1 TOTAL PESTICIDES IN SOIL  
0-5' BGS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C216205P



## **Phase II**

Additional sampling was conducted near the wastewater tank during Phase II to determine the vertical extent of the contaminant concentrations detected during the Phase I investigation.

Although the wastewater tank was the main area of concern for soil at Site 1, additional samples were collected from the Phase II monitoring well installed onsite and the Geoprobe boring in the wetland. Table 5-3 shows the contaminants detected in the Phase II soil samples.

### **5.3 Site 2 Soil Contamination**

#### **Phase I**

Soil was sampled at Site 2 to determine the extent of contamination associated with the former wastewater ponds. During Phase I, 12 soil borings were installed and continuously sampled until groundwater was encountered (samples identified as 2SB-1 [depth], etc.). Analytical results from these soil samples are presented in Table 5-4.

Methylene chloride and 1,2-dichloroethane were detected in several samples at Site 2. Figures 5-2 and 5-3 present isopleth maps displaying concentration contours for these two compounds. The data used to produce the contours were collected from 20 to 30 feet. These compounds were also detected at shallower depths, but less frequently and at lower concentrations than at the 20- to 30-foot interval.

Several other VOCs, SVOCs, and pesticides were detected in the Site 2 borings. Isopleth maps for total VOCs, SVOCs, and pesticides at various depths are presented as Figures 5-4, 5-5, 5-6, 5-7, 5-8 and 5-9. Due to sample collection method (e.g., samples collected based on headspace analysis) the intervals for these maps are not consistent. Therefore, the intervals have been divided into 0 to 25 feet bgs contours and 25 feet to terminal depth of boring intervals.



Table 5-3  
Cedar Chemical  
Phase II Facility Investigation  
Site 1 - Soil Data

Compound	1MW-7 (0-3')	1HA-7 (2-3')	1HA-7 (5-6')	1SB-1 (0-2')	1SB-1 (12-14')
Volatiles (ppb)					
Acetone	U	U	U	190	100
1,2-Dichloroethane	16	U	U	U	U
Toluene	6	U	U	U	U
Xylenes (total)	15	U	U	U	U
Pesticides (ppb)					
4,4'-DDT	U	U	U	4	U
4,4'-DDE	U	23	13	10	U
4,4'-DDD	U	19	20	U	U

*Note:*

U Not quantified above PQLs



**Table 5-4**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 2 Soil Data**

Compound	2SB-1 (15-20')	2SB-1 (25-30')	2SB-2 (20-25')	2SB-2 (25-30')	2SB-3 (13-14')
<b>Volatiles (ppb)</b>					
Benzene	U	U	U	U	1
1,2-Dichloroethane	3,300	4,100	70,000	9,600	12
2-Pentanone	U	U	U	U	67
Toluene	U	U	U	U	3
Chlorobenzene	U	U	U	U	U
Xylene	U	450	U	U	7
Carbon Tetrachloride	U	U	U	U	U
Acetone	1,500	U	U	1,100	25
Chloroform	U	U	U	U	U
Methylene Chloride	13,000	110,000	45,000	40,000	68
1,2-Dichloropropane	U	U	U	U	U
2-Butanone	U	1,600	U	U	22
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	67	46	12,000	2,900	25,000
Phenol	440	580	540	360	U
Bis-(2-chloroethyl)ether	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Propanil	200	100	240	U	11,000
Di-n-butyl Phthalate	70	53	U	120	U
2-Nitrophenol	U	U	400	U	720
Dinoseb	U	U	850	180	29,000
2-Chloronaphthalene	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
Endrin	U	U	U	U	U
Methoxychlor	U	U	U	U	U
Heptachlor	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	12	8	12	8	11
Arsenic	11	4	9	5	9
Barium	140	151	205	133	228
Cadmium	0	1	U	U	U
Chromium	14	9	15	12	11
Selenium	U	U	U	U	U

**Note:**

U Not detected above PQLs



**Table 5-4**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 2 Soil Data**

Compound	2SB-3 (24-25')	2SB-4 (15-20')	2SB-4 (25-30')	2SB-5 (15-20')	2SB-5 (25-30')
<b>Volatiles (ppb)</b>					
Benzene	620	10	U	120	U
1,2-Dichloroethane	620	270	2,600	1,800	110,000
2-Pentanone	1,200	180	U	20	U
Toluene	U	1,200	U	27	U
Chlorobenzene	U	25	U	14	U
Xylene	620	49	U	550	U
Carbon Tetrachloride	U	U	U	U	U
Acetone	U	1,000	2,600	150	U
Chloroform	620	18	U	250	U
Methylene Chloride	8,100	1,200	100,000	1,900	380,000
1,2-Dichloropropane	U	U	U	32	U
2-Butanone	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	22,000	U	120	9,200	3,100
Phenol	U	U	1,000	U	U
Bis-(2-chloroethyl)ether	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Propanil	2,000	U	100	1,200	6,400
Di-n-butyl Phthalate	U	80	100	U	U
2-Nitrophenol	U	U	U	U	U
Dinoseb	U	U	U	U	49,000
2-Chloronaphthalene	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	U	U	140
alpha-BHC	U	10	U	U	44
beta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
Endrin	U	U	U	U	75
Methoxychlor	U	230	U	160,000	160,000
Heptachlor	U	U	U	U	81
<b>Metals (ppm)</b>					
Lead	11	14	13	7	14
Arsenic	8	7	15	9	6
Barium	145	219	126	152	181
Cadmium	U	U	1	U	1
Chromium	12	17	12	10	16
Selenium	U	U	U	U	U

*Note:*

U Not detected above PQLs



**Table 5-4**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 2 Soil Data**

Compound	2SB-6 (21-22')	2SB-6 (28-29')	2SB-7 (10-15')	2SB-7 (15-30')	2SB-8 (15-20')
<b>Volatiles (ppb)</b>					
Benzene	U	U	U	U	U
1,2-Dichloroethane	32,000	170,000	11	U	130
2-Pentanone	U	U	12	U	27
Toluene	U	U	4	20,000	85
Chlorobenzene	U	U	U	U	13
Xylene	U	4,800	U	U	U
Carbon Tetrachloride	U	U	U	U	U
Acetone	U	U	210	2,400	980
Chloroform	U	2,800	U	260	50
Methylene Chloride	170,000	82,000	46	U	1,100
1,2-Dichloropropane	U	U	U	U	U
2-Butanone	U	U	21	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	4,200	9,700	U	1,100	880
Phenol	330	U	U	U	3,100
Bis-(2-chloroethyl)ether	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Propanil	670	11,000	270	U	2,100
Di-n-butyl Phthalate	U	U	74	U	220
2-Nitrophenol	U	U	U	53	89
Dinoseb	10,000	93,000	U	U	U
2-Chloronaphthalene	U	U	U	72	U
1,2-Dichlorobenzene	U	U	U	U	150
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	500	U	U	U
alpha-BHC	U	210	14	U	30
beta-BHC	U	U	U	U	U
4,4'-DDT	U	870	U	U	U
Endrin	U	680	U	U	U
Methoxychlor	16,000	290,000	U	17,000	U
Heptachlor	U	270	U	U	U
<b>Metals (ppm)</b>					
Lead	17	13	14	17	9
Arsenic	19	4	11	12	7
Barium	178	99	197	102	180
Cadmium	U	1	0	0	U
Chromium	15	14	14	18	9
Selenium	U	U	U	U	U

**Note:**

U Not detected above PQLs



**Table 5-4**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 2 Soil Data**

Compound	2SB-8 (25-30')	2SB-9 (4-5')	2SB-9(26-27')	2SB-10 (15-20)	2SB-10 (25-30')
<b>Volatiles (ppb)</b>					
Benzene	17	2	420	U	U
1,2-Dichloroethane	220	14	2,900	U	U
2-Pentanone	79	U	U	U	20
Toluene	1,200	15	5,000	390,000	1,100
Chlorobenzene	100	3	530	U	U
Xylene	170	15	2,600	2,800	U
Carbon Tetrachloride	U	U	670	U	U
Acetone	10,000	26	U	U	240
Chloroform	1,100	2	13,000	U	64
Methylene Chloride	2,100	28	93,000	U	370
1,2-Dichloropropane	U	U	U	U	U
2-Butanone	U	U	U	1,700	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	900	1,200	320	U	U
Phenol	22,000	3,300	1,500	2,500	U
Bis-(2-chloroethyl)ether	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	1,200	U
Propanil	4,800	10,000	8,600	47,000	93
Di-n-butyl Phthalate	U	U	U	U	U
2-Nitrophenol	400	U	U	2,900	U
Dinoseb	510	1,100	920	990	U
2-Chloronaphthalene	U	U	310	850	U
1,2-Dichlorobenzene	1,100	5,300	12,000	11,000	U
3,4-Dichloroaniline	U	U	U	5,300	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
Endrin	U	U	U	U	U
Methoxychlor	1,900	240,000	U	U	U
Heptachlor	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	11	9	17	12	14
Arsenic	28	11	9	9	10
Barium	174	89	184	202	109
Cadmium	U	1	U	1	U
Chromium	20	11	15	13	20
Selenium	1	1	U	U	U

*Note:*

U Not detected above PQLs



**Table 5-4**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 2 Soil Data**

Compound	2SB-11 (20-25')	2SB-11 (25-30')	2SB-12 (15-20')	2SB-12 (25-30')	2MW-1 (15-20')
<b>Volatiles (ppb)</b>					
Benzene	U	U	U	U	U
1,2-Dichloroethane	40	170	3,400	63	43
2-Pentanone	U	U	U	60	U
Toluene	90	180	170	30	U
Chlorobenzene	U	U	U	U	U
Xylene	7	U	U	U	U
Carbon Tetrachloride	U	U	U	U	U
Acetone	84	17,000	U	7,400	U
Chloroform	39	2,700	620	1,100	U
Methylene Chloride	340	U	45,000	4,100	320
1,2-Dichloropropane	U	U	U	U	U
2-Butanone	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	180	560	9,200	710	U
Phenol	280	460	100,000	6,900	U
Bis-(2-chloroethyl)ether	U	U	U	180	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Propanil	6,400	300	79,000	670	330
Di-n-butyl Phthalate	130	150	3,200	U	110
2-Nitrophenol	U	U	U	150	U
Dinoseb	U	U	9,800	U	U
2-Chloronaphthalene	U	U	5,400	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	7	U	U	U	U
4,4'-DDT	U	U	U	U	U
Endrin	U	U	U	U	U
Methoxychlor	U	U	22,000	63,000	U
Heptachlor	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	18	13	8	8	9
Arsenic	9	20	8	24	11
Barium	188	172	153	85	187
Cadmium	1	0	U	0	1
Chromium	18	20	13	13	10
Selenium	U	U	U	U	U

*Note:*

U Not detected above PQLs



Table 5-4  
Cedar Chemical  
Phase I Facility Investigation  
Site 2 Soil Data

Compound	2MW-1 (20-25')	2MW-1 (30-35')	2MW-2 (5-10')	2MW-2 (15-20')	2MW-3 (15-30')
<b>Volatiles (ppb)</b>					
Benzene	U	U	U	U	U
1,2-Dichloroethane	U	U	U	U	35
2-Pentanone	U	33	U	U	9
Toluene	U	U	U	U	29
Chlorobenzene	U	U	U	U	U
Xylene	U	U	U	U	3
Carbon Tetrachloride	U	U	U	U	U
Acetone	U	13	U	U	35
Chloroform	U	U	U	U	190
Methylene Chloride	25,000	160	U	U	250
1,2-Dichloropropane	U	U	U	U	U
2-Butanone	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
Phenol	750	170	U	U	2,700
Bis-(2-chloroethyl)ether	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Benzoic Acid	540	U	U	U	U
Propanil	260	U	460	U	90
Di-n-butyl Phthalate	U	95	U	U	U
2-Nitrophenol	U	U	U	U	U
Dinoseb	U	U	U	U	U
2-Chloronaphthalene	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	U	U	390	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	U	U	U
alpha-BHC	U	U	4	U	U
beta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
Endrin	U	U	U	U	U
Methoxychlor	U	U	U	U	U
Heptachlor	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	7	9	21	15	10
Arsenic	9	5	8	12	11
Barium	158	84	197	178	151
Cadmium	U	0	U	1	U
Chromium	11	14	15	18	14
Selenium	U	U	U	U	U

Note:

U Not detected above PQLs



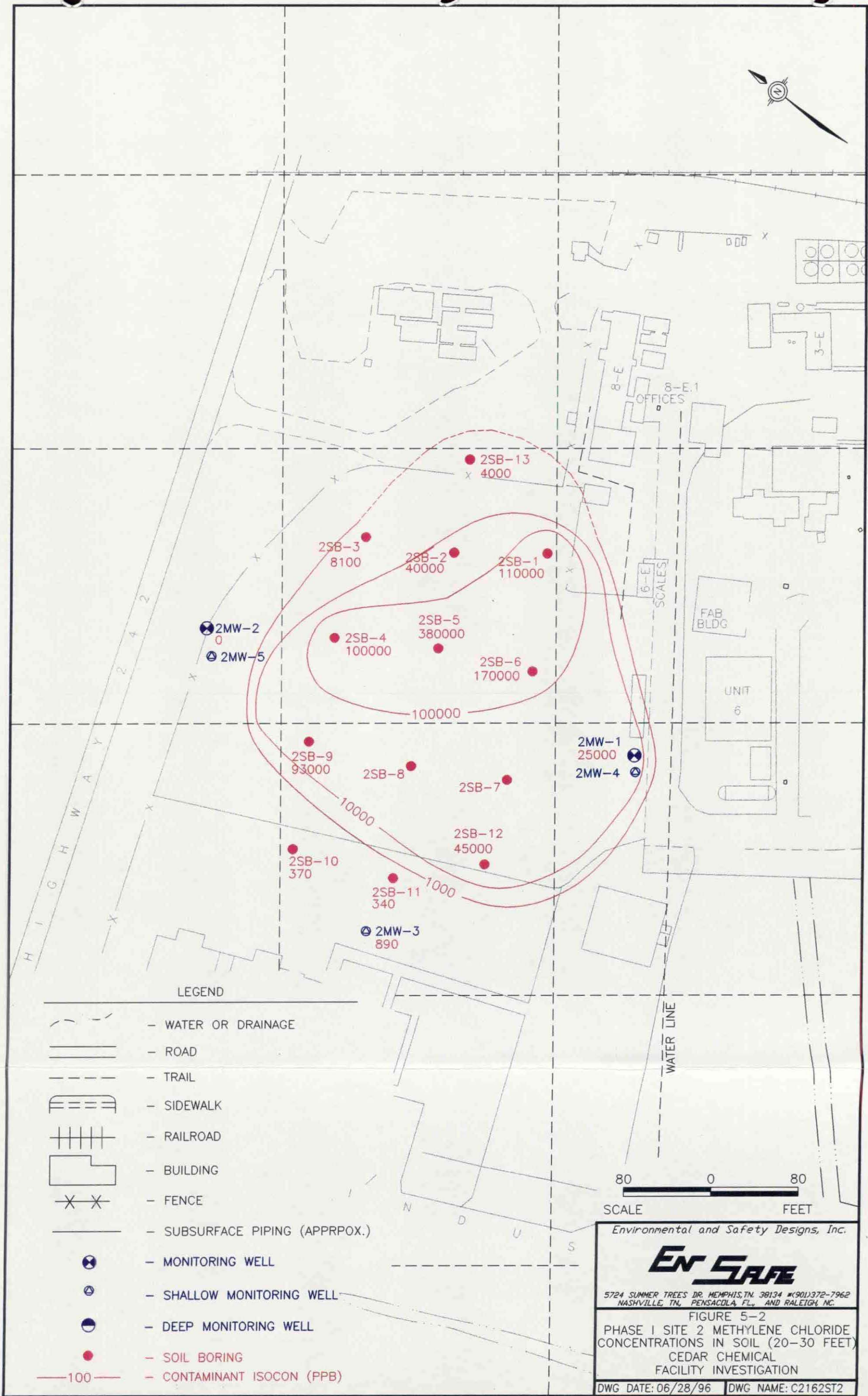
**Table 5-4**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 2 Soil Data**

Compound	2MW-3 (20-25')	2MW-3 (30-35')
<b>Volatiles (ppb)</b>		
Benzene	U	U
1,2-Dichloroethane	74	110
2-Pentanone	50	1,000
Toluene	140	190
Chlorobenzene	U	U
Xylene	U	U
Carbon Tetrachloride	U	U
Acetone	3,100	2,700
Chloroform	390	10
Methylene Chloride	890	26
1,2-Dichloropropane	U	U
2-Butanone	35	U
<b>Semivolatiles (ppb)</b>		
4-Nitrophenol	1,600	U
Phenol	49,000	U
Bis-(2-chloroethyl)ether	U	U
1,2,4-Trichlorobenzene	U	U
Benzoic Acid	U	U
Propanil	190	120
Di-n-butyl Phthalate	U	320
2-Nitrophenol	U	U
Dinoseb	U	U
2-Chloronaphthalene	U	U
1,2-Dichlorobenzene	U	U
3,4-Dichloroaniline	310	250
<b>Pesticides (ppb)</b>		
Aldrin	U	U
alpha-BHC	U	U
beta-BHC	U	U
4,4'-DDT	U	U
Endrin	U	U
Methoxychlor	U	U
Heptachlor	U	U
<b>Metals (ppm)</b>		
Lead	10	7
Arsenic	11	6
Barium	133	88
Cadmium	0	U
Chromium	15	8
Selenium	U	U

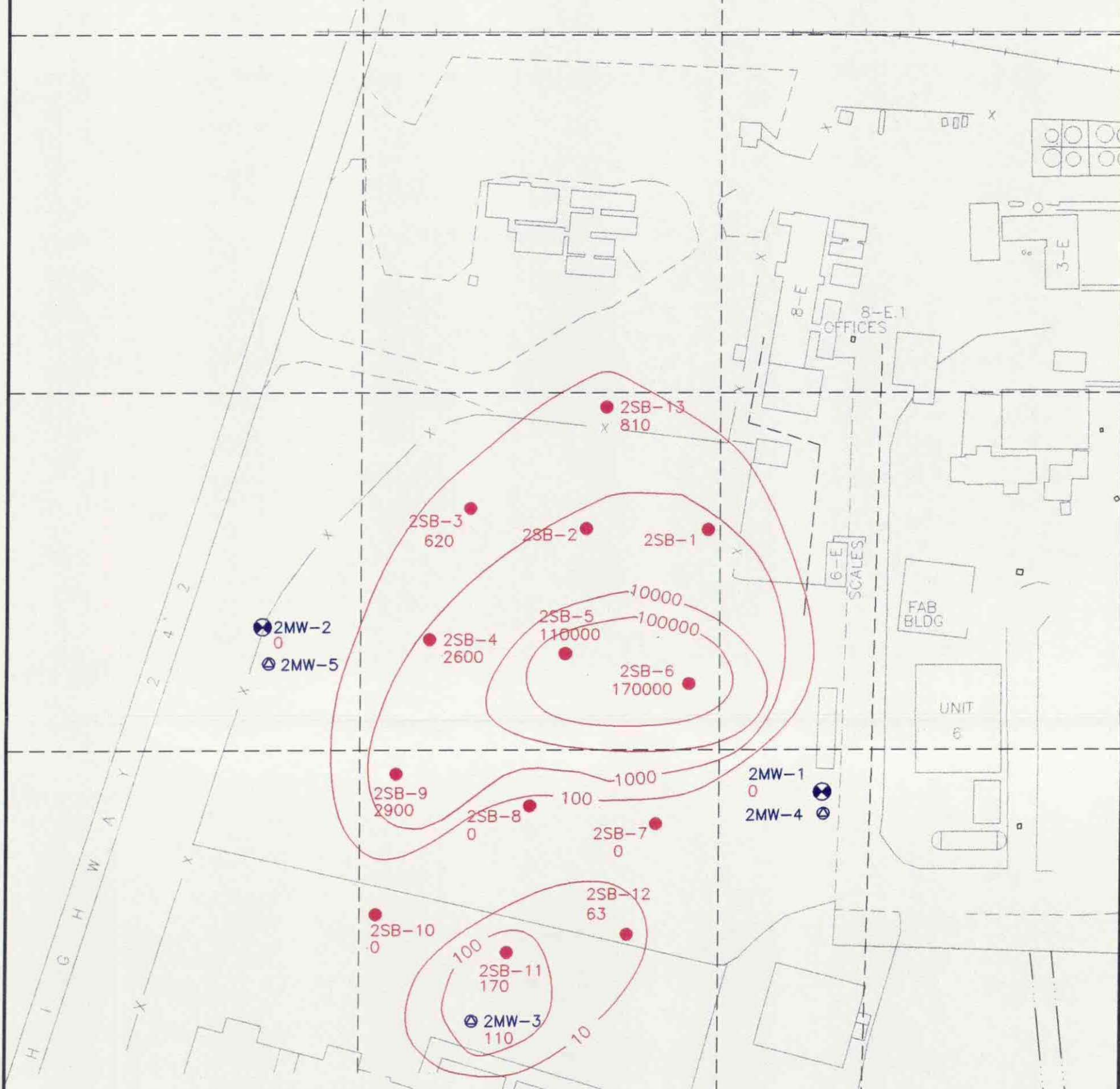
*Note:*

U Not detected above PQLs









LEGEND

- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPRPOX.)

- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL

- SOIL BORING
- CONTAMINANT ISOCON (PPB)

— 100 —

80 0 80  
SCALE FEET

Environmental and Safety Designs, Inc.

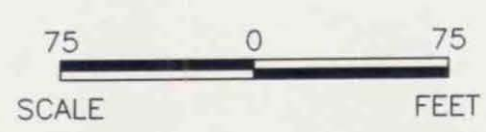
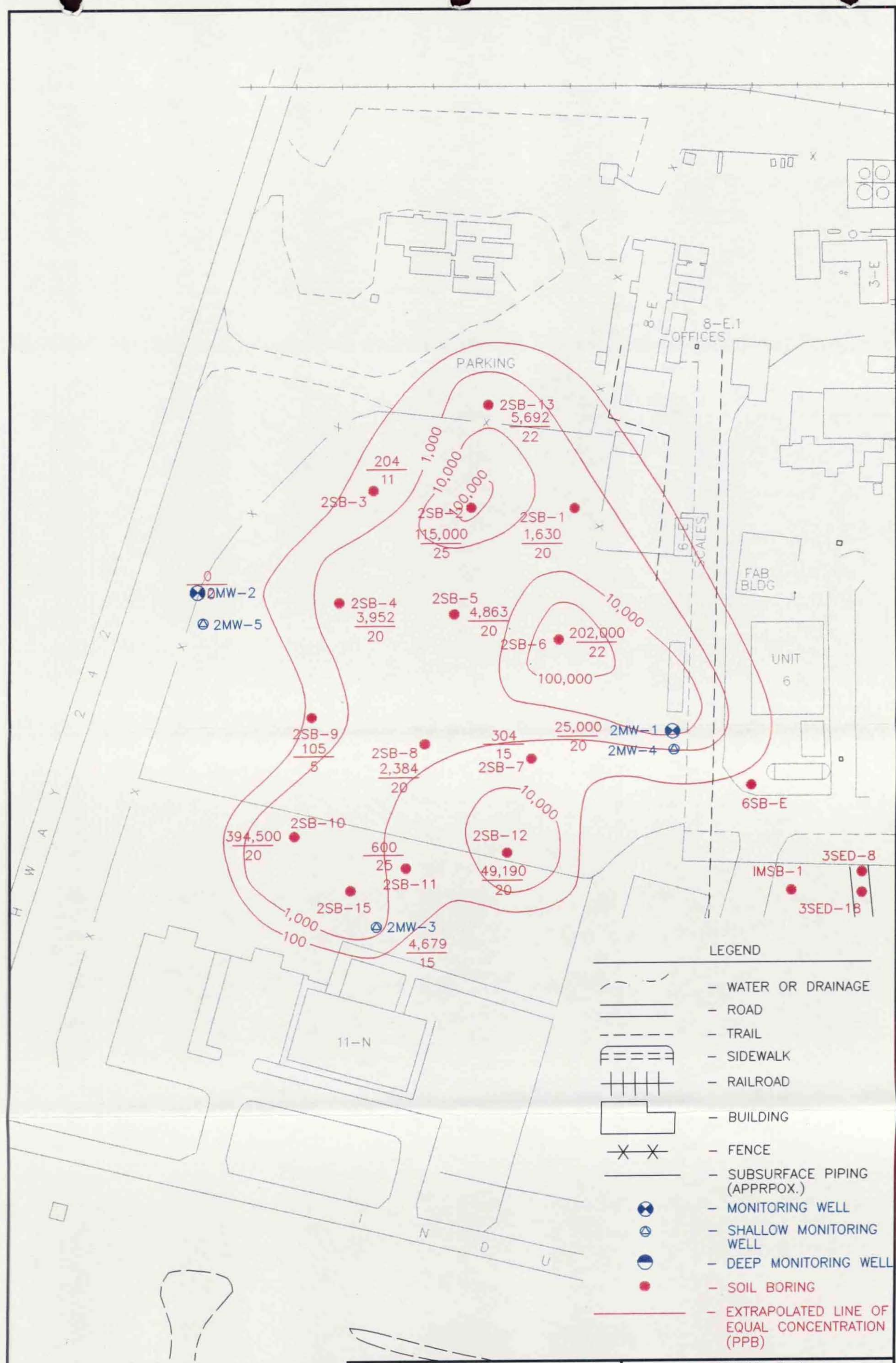
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FIGURE 5-3  
PHASE I SITE 2 DICHLOROETHANE  
CONCENTRATIONS IN SOIL (20-30 FEET)  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162F52

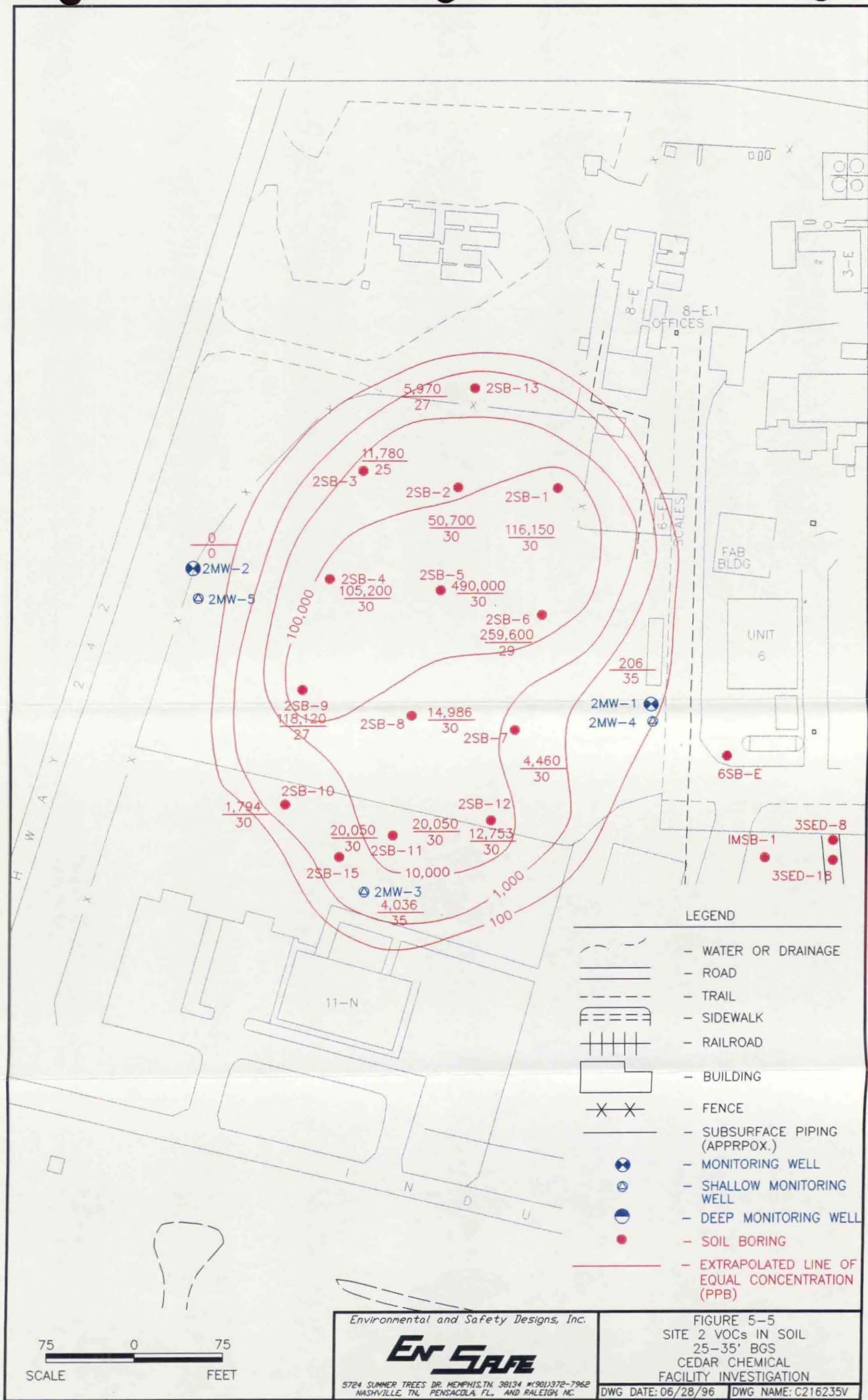




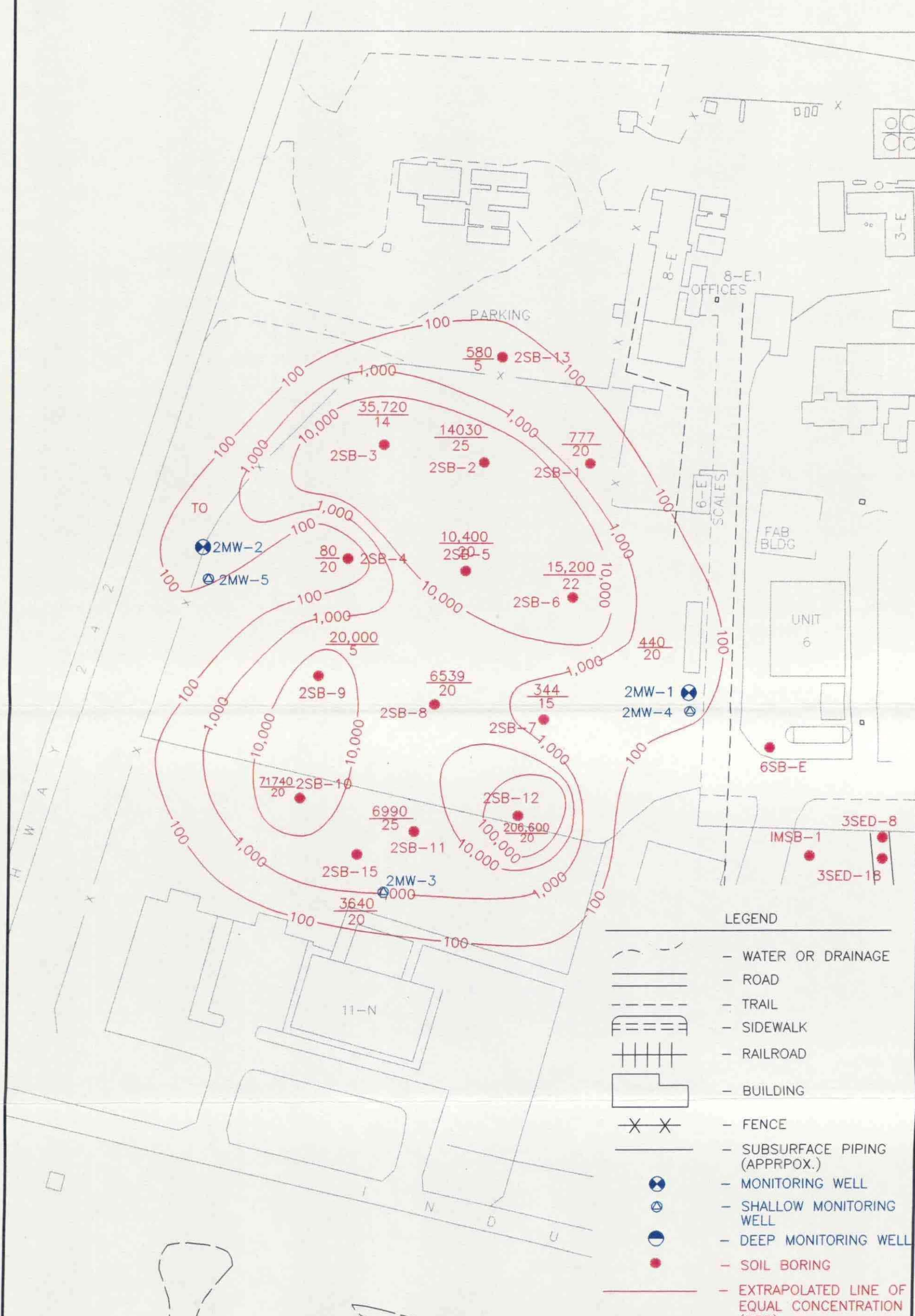
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FIGURE 5-4  
 SITE 2 TOTAL VOCs IN SOIL  
 0-25' BGS  
 CEDAR CHEMICAL  
 FACILITY INVESTIGATION  
 DWG DATE: 06/28/96 DWG NAME: C216225V





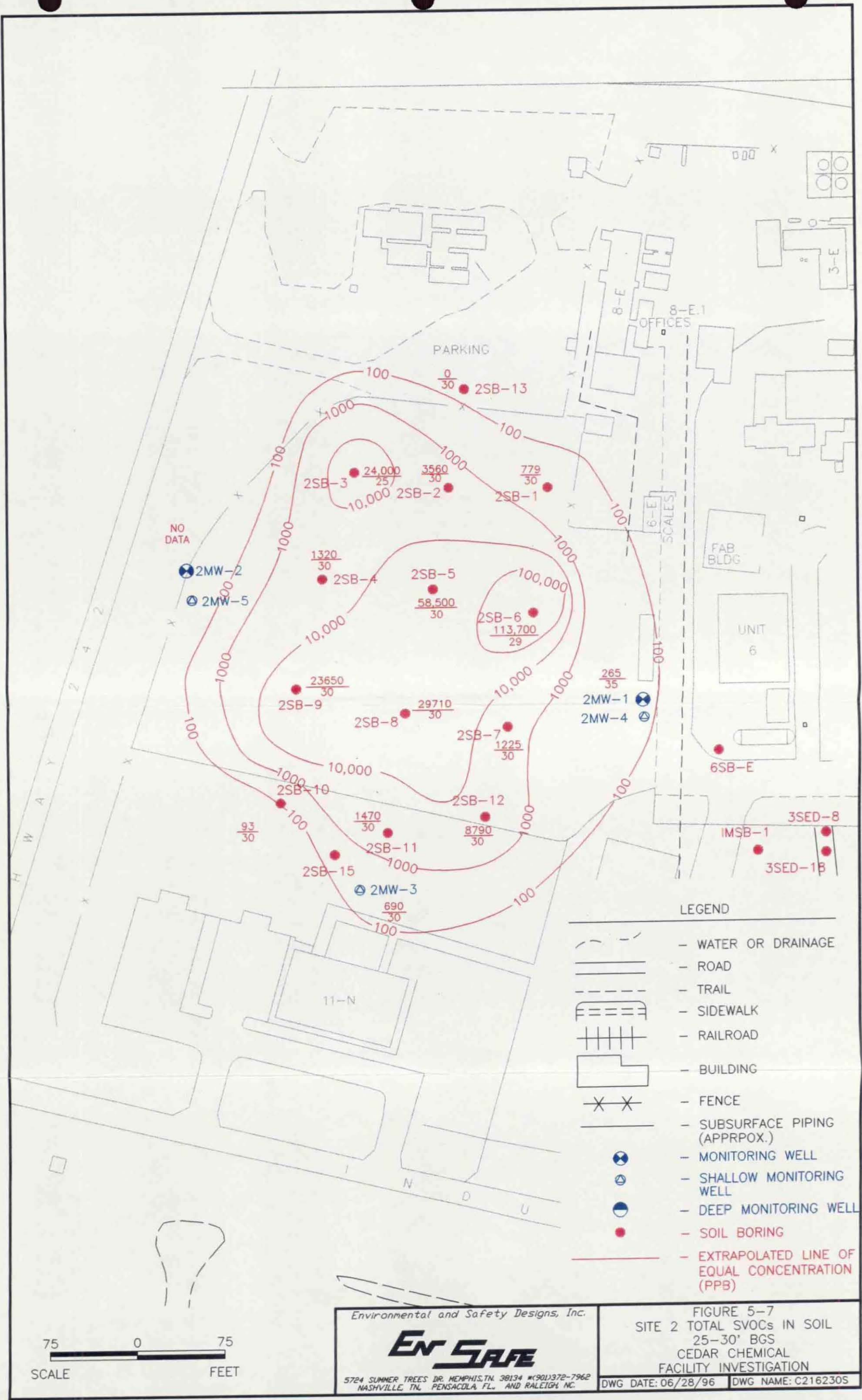




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FIGURE 5-6  
 SITE 2 TOTAL SVOCs IN SOIL  
 0-25' BGS  
 CEDAR CHEMICAL  
 FACILITY INVESTIGATION  
 DWG DATE: 06/28/96 DWG NAME: C216225S





LEGEND

- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- SOIL BORING
- EXTRAPOLATED LINE OF EQUAL CONCENTRATION (PPB)

75 0 75  
SCALE FEET

Environmental and Safety Designs, Inc.

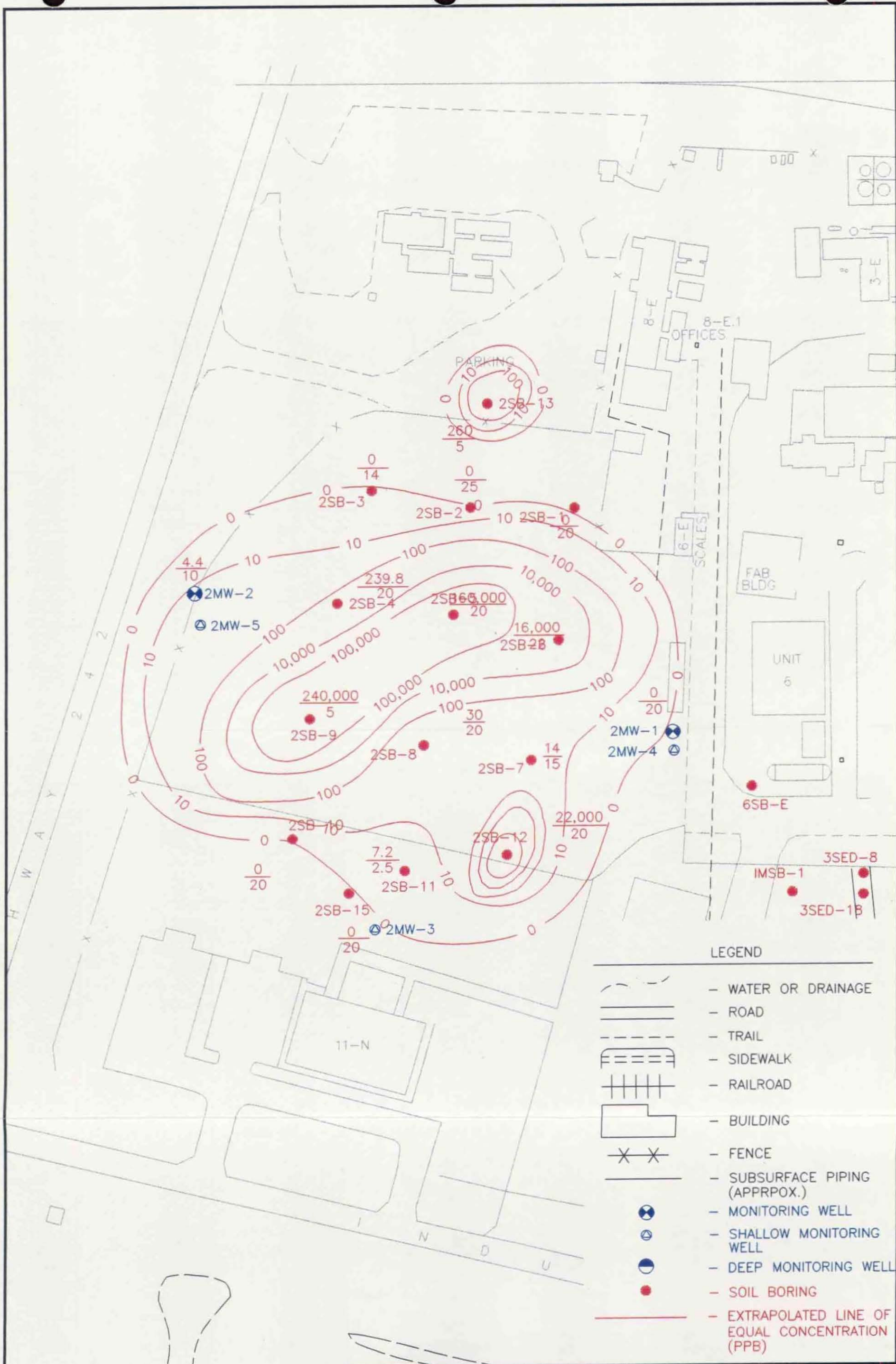
**EN SAFE**

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FIGURE 5-7  
SITE 2 TOTAL SVOCs IN SOIL  
25-30" BGS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162305





LEGEND

- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- SOIL BORING
- EXTRAPOLATED LINE OF EQUAL CONCENTRATION (PPB)

75 0 75  
SCALE FEET

Environmental and Safety Designs, Inc.

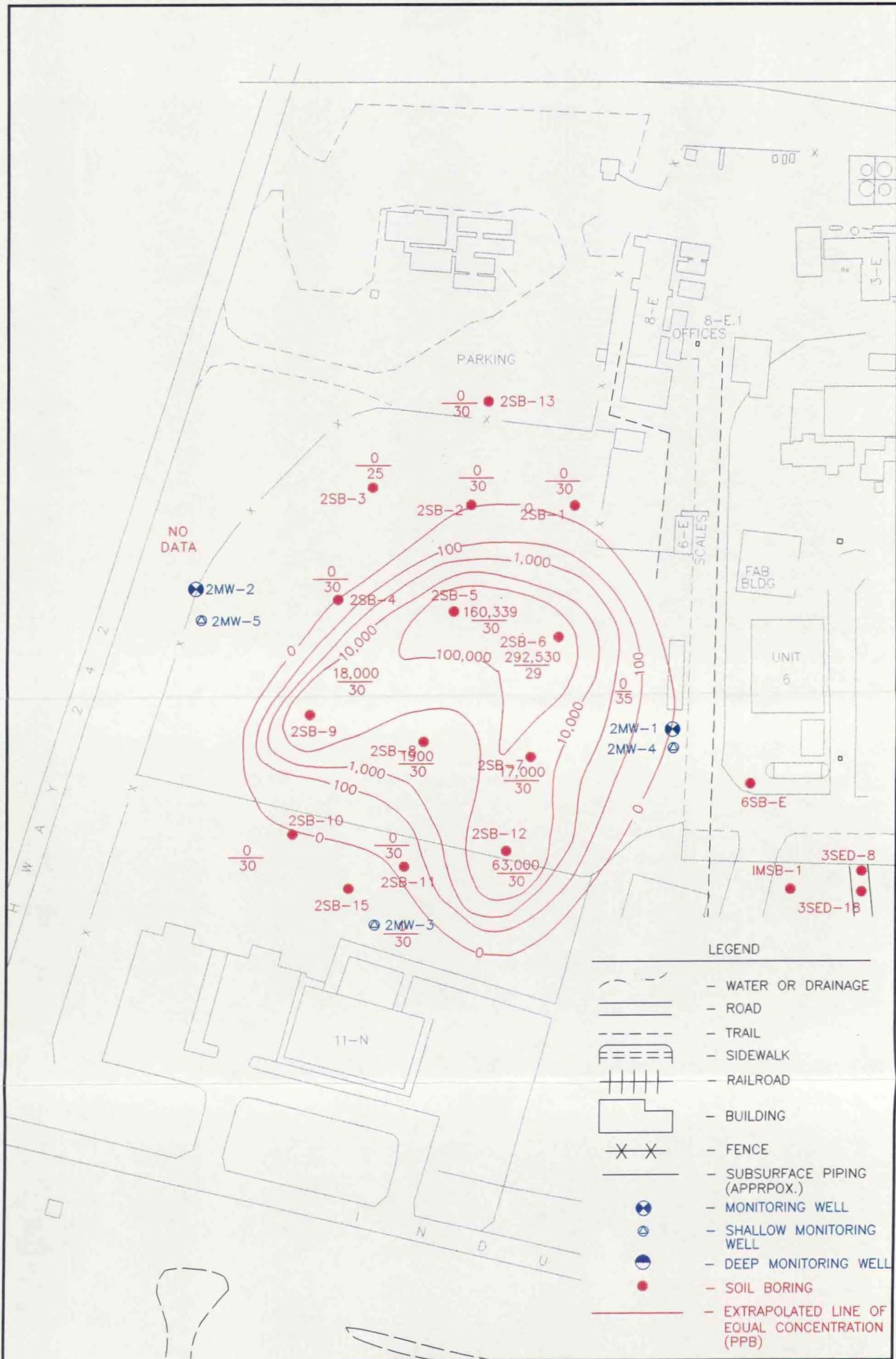
**EN SAFE**

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NASHVILLE, TN. PENSACOLA, FL. AND RALEIGH, NC.

FIGURE 5-8  
SITE 2 TOTAL PESTICIDES IN SOIL  
0-25' BGS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C216225P





75 0 75  
SCALE FEET

Environmental and Safety Designs, Inc.

**ENSAFE**

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NASHVILLE, TN. PENSACOLA, FL. AND RALEIGH, NC.

FIGURE 5-9  
SITE 2 TOTAL PESTICIDES IN SOIL  
25-30' BGS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C216230P



In addition to the soil borings installed within the pond boundaries, five groundwater monitoring wells were installed along the site perimeter. Soil samples were collected continuously from these well borings at 5-foot intervals (samples identified as 2MW-1 [depth], etc.). Data from the soil samples collected during monitoring well installation have been incorporated into the isopleth maps.

### **Phase II**

Phase II soil sampling included installing and sampling one soil boring (1SB-13) north of the former ponds and two additional monitoring wells (2MW-6 and 2MW-7) near the intersection of Highway 242 and Industrial Park Road. Samples collected from the soil boring are identified as 2SB-13 (x-y), where x-y represents the depth interval from which the sample was collected. Since wells 2MW-6 and 2MW-7 were installed as a nested pair, soil samples only were collected from the well 2MW-7 boring. Result for the Site II samples collected during Phase II are presented in Table 5-5.

### **Phase III**

Three samples associated with Site 2 were collected. One sample was collected adjacent to monitoring well 2MW-7 to confirm the methoxychlor detected during the installation of this well, and two in an area of stressed vegetation in and extending off Site 2.

Sample 2SB-14 (8-10') was collected from approximately the same interval as the sample exhibiting the elevated methoxychlor. The sample contained no detectable concentrations of SVOCs or pesticides. There are two possible explanations for the discrepancy between the two samples. The first possibility is that the methoxychlor was introduced into the sample during collection or analysis from some unknown exogenous source. Secondly, a small area of methoxychlor may be present at this depth, but the impacted area is so small that a sample with detectable concentrations cannot be reproduced.



**Table 5-5**  
**Cedar Chemical**  
**Phase II Facility Investigation**  
**Site 2 - Soil Data**

Compound	2MW-7 (0-5')	2MW-7 (5-10')	2MW-7 (20-25')	2SB-13 (0-2')	2SB-13 (8-10')	2SB-13 (10-12')
<b>Volatiles (ppb)</b>						
Acetone	U	840	1,200	U	820	1,600
1,2-Dichloroethane	U	U	U	U	810	740
Chlorobenzene	U	U	U	U	24	30
Methylene Chloride	U	U	U	U	4,000	3,600
Xylene (total)	U	U	U	U	38	U
<b>Semivolatiles (ppb)</b>						
Dinoseb	U	U	U	U	580	U
<b>Pesticides (ppb)</b>						
Methoxychlor	180	280,000	U	260	U	U
Aldrin	U	U	U	U	U	U
4,4'-DDT	U	U	U	U	U	U
4,4'-DDD	U	49	U	U	U	U

*Note:*

U Not quantified above PQLs



The remaining two samples collected in one of the areas of stressed vegetation had detectable concentrations of several chlorinated pesticides. The compounds detected in samples 2SB-15 (0-2') and 2SB-15 (8-10') are fairly consistent with those observed in previous Site 2 soil samples. Results for these samples are presented in Table 5-6.

#### **5.4 Site 3 Soil Contamination**

##### **Phase I**

Phase I soil sampling was conducted to determine if contaminants in surface runoff had impacted the sediment in the storm water ditches. Ten ditch sediment samples were collected and analyzed for VOCs, SVOCs, pesticides, and metals. Table 5-7 shows the contaminants detected during the Phase I FI in the storm water ditches.

##### **Phase II**

As a result of the concentrations of compounds detected in the storm water ditch sediments during the Phase I FI, additional sampling was conducted during Phase II to compare the sediment contaminant concentrations with those migrating into native soil.

Samples collected from 12 ditch locations during Phase II were analyzed for pesticides and metals. Yellow staining was encountered while installing a lithologic boring near the ditches. Samples collected from this boring were analyzed for SVOCs. These samples were identified as 3LB-6. Table 5-8 presents the constituents detected in the Phase II soil samples.

##### **Phase III**

During the third phase, one boring (3-SB1) was installed and sampled 25 feet northwest of boring 3LB-6 to assess the vertical migration of the dinoseb detected in the Phase II samples. Boring 3SB-1 was sampled continuously until soil staining was no longer visible. Two samples were submitted for chemical analysis: sample 3SB1 (4-6') was collected from the interval with the heaviest yellow staining, and sample 3SB1 (10-12') was collected from the deepest interval where staining was no longer visible. Dinoseb was detected at 180,000 ppb in sample 3SB-1 (4-6') and at 630 ppb in sample 3SB-1(10-12'). Results for both samples are presented in Table 5-9.



Table 5-6  
Cedar Chemical  
Phase III Facility Investigation  
Site 2 Soil Data

Compound	2SB-14 (8-10')	2SB-15 (0-2')	2SB-15 (8-10')
Pesticides (ppb)			
Aldrin	U	11	16
Dieldrin	U	U	9.5
4,4'-DDE	U	11	U
4,4'-DDD	U	15	U
4,4'-DDT	U	20	11
Endrin	U	7	U
Methoxychlor	U	55	U
Endosulfan Sulfate	U	U	17
Endrin Keytone	U	U	6.4

*Notes:*

U Not detected above PQLs



Table 5-7  
Cedar Chemical  
Phase I Facility Investigation  
Site 3 Sediment Data

Compound	3SED-1	3SED-2	3SED-3	3SED-4	3SED-5
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	7
1,2-Dichloroethane	U	U	U	U	U
Chlorobenzene	U	34	11	U	U
Total Xylenes	U	U	U	U	44
Acetone	U	U	130	U	U
Methylene Chloride	U	U	U	U	2
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	350	U	U	U	U
4-Chloroaniline	U	190	500	U	U
Di-n-octylphthalate	U	U	U	U	U
1,2,4-Trichlorobenzene	U	230	92	U	U
Propanil	U	110	44	U	U
Di-n-butylphthalate	U	U	U	U	U
Pentachlorophenol	5,300	200	U	U	U
Dinoseb	U	U	U	U	U
Naphthalene	U	U	U	U	86
2-Methylnaphthalene	U	U	U	U	550
1,2-Dichlorobenzene	U	U	300	U	120
3,4-Dichloroaniline	U	2,800	1,300	440	100,000
<b>Pesticides (ppb)</b>					
Aldrin	U	U	354	U	U
4,4'-DDT	U	U	8	U	U
Endrin Ketone	U	U	U	U	U
Dieldrin	U	12	3,400	3	57
Methoxychlor	3,600	260	2,400	U	U
44'-DDD	U	39	U	U	U
4,4'-DDE	U	7	U	8	U
<b>Metals (ppm)</b>					
Lead	7	14	10	9	10
Arsenic	7	7	5	4	7
Barium	114	138	96	87	114
Chromium	10	17	16	12	11

*Notes:*

U Not detected above PQLs



Table 5-7  
Cedar Chemical  
Phase I Facility Investigation  
Site 3 Sediment Data

Compound	3SED-6	3SED-7	3SED-8	3SED-9	3SED-10
Volatiles (ppb)	U	U	U	U	U
Ethylbenzene	U	U	U	U	2
1,2-Dichloroethane	U	U	U	U	43
Chlorobenzene	U	U	U	U	U
Total Xylenes	U	U	U	U	12
Acetone	U	U	U	U	U
Methylene Chloride	U	U	U	U	160
Semivolatiles (ppb)					
4-Nitrophenol	U	U	U	U	U
4-Chloroaniline	U	U	U	U	U
Di-n-octylphthalate	U	U	180	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Propanil	U	U	U	U	U
Di-n-butylphthalate	U	U	U	U	U
Pentachlorophenol	U	U	U	U	U
Dinoseb	U	4,000	U	U	U
Naphthalene	U	U	U	U	U
2-Methylnaphthalene	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	400	370	840	310	U
Pesticides (ppb)					
Aldrin	U	U	U	U	
4,4'-DDT	U	U	U	U	12
Endrin Ketone	U	U	U	U	19
Dieldrin	86	200	34	5	U
Methoxychlor	740	890	1,300	U	U
44'-DDD	U	U	U	U	29
4,4'-DDE	U	U	U	U	26
Metals (ppm)					
Lead	12	12	8	11	11
Arsenic	13	7	9	222	4
Barium	123	143	112	150	215
Chromium	19	16	10	12	8

Notes:

U Not detected above PQLs



Table 5-8  
Cedar Chemical  
Phase II Facility Investigation  
Site 3 - Sediment Data

Sample	Compounds Detected									Semivolatiles (ppb)	Metals (ppm)
	Pesticides (ppb)									Dinoseb	Arsenic
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Dieldrin	Methoxychlor	delta-BHC	Endrin	Toxaphene		
3SED-1-S	U	5	15	U	U	U	U	U	U	U	U
3SED-1-N	U	U	U	U	U	U	U	U	U	U	U
3SED-2-S	U	U	U	U	U	630	U	U	U	U	U
3SED-2-N	U	U	U	U	U	U	U	U	U	U	U
3SED-3-S	76	U	U	U	U	380	U	U	U	U	U
3SED-3-N	8	U	U	8	2	U	U	U	U	U	U
3SED-4-S	U	U	U	U	6	U	U	U	U	U	U
3SED-4-N	U	U	U	U	U	U	U	U	U	U	U
3SED-5-S	U	U	U	U	U	2,400	U	U	U	U	U
3SED-5-N	U	U	U	U	U	U	U	U	U	U	U
3SED-6-S	27	U	U	U	U	410	U	U	U	U	U
3SED-6-N	38	16	U	U	U	360	U	U	U	U	U
3SED-7-S	21	U	U	3	U	2,500	U	U	U	U	U
3SED-7-N	68	33	U	U	U	320	U	U	U	U	U
3SED-8-S	U	U	U	U	U	1,900	U	U	U	U	U
3SED-8-N	U	U	U	U	U	U	U	U	U	U	U
3SED-9-S	U	U	U	U	U	130	U	U	U	U	U
3SED-9-N	U	U	U	U	U	210	U	U	U	U	U
3SED-10-S	36	U	U	27	220	2,000	U	U	U	U	U
3SED-10-S (dup)	180	78	U	58	550	1,200	U	U	U	U	U
3SED-10-N	170	72	U	U	11	U	18	U	U	U	U
3SED-11-S	U	U	91	U	U	1,700	U	76	1,600	U	U
3SED-11-N	U	U	U	U	43	220	U	89	U	U	20
3SED-12-S	U	U	U	U	U	750	U	U	U	U	U
3SED-12-N	U	U	U	U	U	210	U	U	U	U	U
3SB-6 (4-8')	U	U	U	U	U	U	U	U	U	13,000,000	U
3SB-6 (8-12')	U	U	U	U	U	U	U	U	U	180,000	U
3SB-6 (12-14')	U	U	U	U	U	U	U	U	U	560,000	U

Note:

U Not quantified above PQLs



**Table 5-9**  
**Cedar Chemical**  
**Phase III Facility Investigation**  
**Site 3 Soil Data**

<b>Compound</b>	<b>3SB-1 (4-6')</b>	<b>3SB-1 (6-8')</b>
<b>Semivolatiles (ppb)</b>		
<b>Dinoseb</b>	<b>180,000</b>	<b>630</b>



## 5.5 Site 4 Soil Contamination

### Phase I

Phase I sampling at Site 4 involved completing of six hand-auger borings along the rail spur parallel to the north end of the plant (loading/unloading area) and two hand-auger borings near the former loading/unloading sump.

Samples were also collected from the borings for two groundwater monitoring wells installed south of the rail spur near the process units to determine if any releases had impacted groundwater. Table 5-10 shows the contaminants detected in the Phase I soil samples collected at Site 4. There was strong olfactory evidence of volatile constituents in well 4MW-1 and strong visual evidence of contamination in well 4MW-2.

### Phase II

Three soil borings installed along the rail spur were and completed at approximately 30 feet bgs. These borings were sampled at 5-foot intervals to determine the extent of contamination detected in the Phase I hand-auger boring samples. The primary contaminants detected in the three soil borings were methoxychlor and dinoseb. Soil samples were collected from wells 4MW-3 and 4MW-4. Figures 5-10 and 5-11 present dinoseb concentrations at various depths at Site 4.

As seen by the data in Table 5-11, most of the contamination is concentrated in the upper 2 to 5 feet of soil. Isophorone was the only contaminant detected below the 15-foot sampling interval.

The constituents 3,4-dichloroaniline and propanil inadvertently were not reported for Phase II samples. To obtain these data, Phase II borings 4SB1, 4SB2, and 4SB3 were resampled according to the methods described in Section 4. Three depth intervals were submitted for analysis from each boring. Of the nine samples obtained, four contained 3,4-dichloroaniline, as follows: 4SB1 (0-2'), 2,100 ppb; 4SB2 (4-6'), 1,400 ppb; 4SB3 (6-8'), 1,900 ppb; and 4SB3 (22-24'), 10,000 ppb. Samples 4SB3 (2-4') and 4SB-3 (22-24') also contained propanil at 130,000 ppb and 2,000 ppb, respectively.



Table 5-10  
Cedar Chemical  
Phase I Facility Investigation  
Site 4 Soil Data

Compound	4HA-1 (0-1')	4HA-1 (1-2')	4HA-1 (2-3')	4HA-2 (0-1')	4HA-2 (1-2')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	4	150
1,2-Dichloroethane	U	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	U	U
Toluene	U	U	U	8	500
Chlorobenzene	U	U	U	U	7
Total Xylenes	U	U	U	U	340
Acetone	U	U	U	19	U
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	U
Carbon Disulfide	U	U	U	U	120
1,1-Dichloroethene	U	U	U	U	U
2-Butanone	U	U	U	17	43
Trichloroethene	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
4-Chloroaniline	U	U	U	U	U
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
Di-n-octylphthalate	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Pyrene	U	U	U	U	U
Dimethylphthalate	U	U	U	U	U
Fluoranthene	U	U	U	U	U
Propanil	U	U	410	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	U	U	U	U	2,700
Dinoseb	U	U	740	500,000	1,100,000
2-Methyphenol	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	U	1,900	4,900	U	7,400
<b>Pesticides (ppb)</b>					
Heptachlor Epoxide	U	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
alpha-BHC	U	8	U	U	U
beta-BHC	U	U	5	U	U
delta-BHC	U	U	U	U	U
Endosulfan II	U	U	U	U	72
4,4'-DDT	U	U	19	260	430
alpha-Chlordan	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Endrin Ketone	U	U	U	U	770
Lindane	U	U	U	U	U
Dieldrin	U	U	50	U	U
Endrin	U	U	U	U	U
Methoxychlor	U	8,100	5,700	15,000	74,000
4,4'-DDD	U	33	84	U	120
4,4'-DDE	7	25	37	56	150
Heptachlor	U	U	U	U	U
Toxaphene	U	U	U	U	U
Endosulfan I	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	6	7	7	8	9
Arsenic	5	5	3	4	4
Silver	U	U	U	U	U
Barium	101	73	111	94	91
Cadmium	U	U	U	U	U
Chromium	12	11	12	14	14
Mercury	U	U	U	U	U

Notes:

U Not detected above PQLs



Table 5-10  
Cedar Chemical  
Phase I Facility Investigation  
Site 4 Soil Data

Compound	4HA-2 (2-3')	4HA-3 (0-1')	4HA-4 (0-1')	4HA-4 (1-2')	4HA-4 (2-3')
<b>Volatiles (ppb)</b>					
Ethylbenzene	110	U	U	U	U
1,2-Dichloroethane	U	U	U	25	320
4-Methyl-2-Pentanone	U	U	U	U	U
Toluene	290	U	U	45	220
Chlorobenzene	U	U	U	U	U
Total Xylenes	270	U	U	U	1
Acetone	U	U	170	31	20
Chloroform	U	U	U	U	25
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	1	3
Carbon Disulfide	68	U	U	U	16
1,1-Dichloroethene	U	U	U	U	2
2-Butanone	U	9	12	17	19
Trichloroethene	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
4-Chloroaniline	U	U	U	12,000	4,500
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
Di-n-octylphthalate	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	470	U
Pyrene	U	U	U	110	U
Dimethylphthalate	U	U	94	U	U
Fluoranthene	U	U	U	130	U
Propanil	U	U	U	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	U	U	U	U	U
Dinoseb	470,000	U	U	U	U
2-Methyphenol	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	160	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Heptachlor Epoxide	U	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
delta-BHC	U	U	U	U	U
Endosulfan II	U	U	3	U	U
4,4'-DDT	170	U	U	U	U
alpha-Chlordan	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Endrin Ketone	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	U	2	U	U
Endrin	U	U	U	U	U
Methoxychlor	15,000	8,400	12,000	26,000	1,600
4,4'-DDD	U	U	U	U	U
4,4'-DDE	75	5	25	280	U
Heptachlor	U	U	U	U	U
Toxaphene	U	U	U	U	U
Endosulfan I	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	8	4	6	9	9
Arsenic	4	3	4	7	8
Silver	U	U	U	U	U
Barium	87	54	53	81	97
Cadmium	U	0	0	U	U
Chromium	14	11	10	9	11
Mercury	U	U	U	U	U

Notes:

U Not detected above PQLs



Table 5-10  
Cedar Chemical  
Phase I Facility Investigation  
Site 4 Soil Data

Compound	4HA-5 (0-1')	4HA-5 (1-2')	4HA-5 (2-3')	4HA-6 (0-1')	4HA-6 (1-2')
<b>Volatiles (ppb)</b>					
Ethylbenzene	7	U	110	U	8
1,2-Dichloroethane	U	U	U	U	U
4-Methyl-2-Pentanone	19	32	120	U	28
Toluene	350	830	10,000	5	100
Chlorobenzene	3	U	35	U	3
Total Xylenes	76	71	4,400	36	290
Acetone	25	U	110	U	130
Chloroform	U	U	U	U	U
Benzene	U	U	2	U	U
Methylene Chloride	U	U	5	U	U
Carbon Disulfide	U	U	U	U	U
1,1-Dichloroethene	U	U	U	U	U
2-Butanone	U	U	28	U	54
Trichloroethene	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
4-Chloroaniline	8,600	9,100	U	U	U
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	1,200	1,300	U	U	U
Di-n-octylphthalate	U	4,300	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Pyrene	U	U	U	U	U
Dimethylphthalate	U	U	U	U	U
Fluoranthene	U	U	U	U	U
Propanil	690	49,000	130,000	2,500	U
Isophorone	U	730	U	U	U
Di-n-butylphthalate	540	460	U	400	U
Dinoseb	1,400	30,000	920,000	190,000	U
2-Methyphenol	U	U	U	U	U
1,2-Dichlorobenzene	1,500	1,700	U	3,700	U
3,4-Dichloroaniline	85,000	2,500,000	400,000	U	12,000,000
<b>Pesticides (ppb)</b>					
Heptachlor Epoxide	U	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	14	U
beta-BHC	U	U	38	U	U
delta-BHC	U	U	U	U	U
Endosulfan II	U	U	U	U	U
4,4'-DDT	U	U	U	100	450
alpha-Chlordan	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Endrin Ketone	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	U	U	190	630
Endrin	U	U	U	U	U
Methoxychlor	3,200	7,400	U	9,400	34,000
4,4'-DDD	44	U	NR	33	140
4,4'-DDE	19	U	19	36	110
Heptachlor	12	U	U	U	U
Toxaphene	U	U	U	U	U
Endosulfan I	U	U	U	32	U
<b>Metals (ppm)</b>					
Lead	13	9	7	10	16
Arsenic	5	4	3	4	5
Silver	U	U	U	U	U
Barium	75	94	113	76	84
Cadmium	U	U	U	0	U
Chromium	19	18	14	14	21
Mercury	U	U	U	U	U

Notes:

U Not detected above PQLs



**Table 5-10**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 4 Soil Data**

Compound	4HA-7 (5-6')	4HA-7 (6-7')	4HA-7 (7-8')	4HA-8 (5-6')	4HA-8 (6-7')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	U
1,2-Dichloroethane	U	31	26	U	U
4-Methyl-2-Pentanone	U	U	U	U	U
Toluene	U	U	U	U	U
Chlorobenzene	U	U	U	U	U
Total Xylenes	U	U	U	U	U
Acetone	U	12	12	U	U
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	U
Carbon Disulfide	U	U	U	U	U
1,1-Dichloroethene	U	U	U	U	U
2-Butanone	U	U	U	U	U
Trichloroethene	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
4-Chloroaniline	U	U	U	U	U
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
Di-n-octylphthalate	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Pyrene	U	U	U	U	U
Dimethylphthalate	180	U	U	U	U
Fluoranthene	U	U	U	U	U
Propanil	U	U	U	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	U	U	U	U	U
Dinoseb	840,000	98,000	19,000	91,000	73,000
2-Methyphenol	U	U	U	U	U
1,2-Dichlorobenzene	120	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Heptachlor Epoxide	U	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
delta-BHC	U	U	U	U	U
Endosulfan II	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
alpha-Chlordan	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Endrin Ketone	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	U	U	U	U
Endrin	U	U	U	U	U
Methoxychlor	U	U	U	U	U
4,4'-DDD	U	U	U	U	U
4,4'-DDE	U	U	U	U	U
Heptachlor	U	U	U	U	U
Toxaphene	U	U	U	U	U
Endosulfan I	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	11	11	9	11	13
Arsenic	7	7	6	7	8
Silver	U	U	U	U	U
Barium	106	118	127	113	118
Cadmium	U	U	U	U	U
Chromium	18	15	11	18	15
Mercury	U	U	U	U	U

Notes:

U Not detected above PQLs



**Table 5-10**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 4 Soil Data**

Compound	4HA-8 (7-8')	4MW-1 (10-15')	MW-2 (25-30')	4MW-2 (0-5')	MW-2 (25-30')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	9	U	U	U
1,2-Dichloroethane	U	120	650	U	U
4-Methyl-2-Pentanone	U	31	23	U	U
Toluene	U	56,000	670	2	U
Chlorobenzene	U	U	U	U	U
Total Xylenes	U	96	68	U	U
Acetone	U	99	1,200	27	U
Chloroform	U	12	U	U	U
Benzene	U	29	U	U	U
Methylene Chloride	U	130	270	U	9
Carbon Disulfide	U	U	U	U	U
1,1-Dichloroethene	U	U	U	U	U
2-Butanone	U	U	U	60	U
Trichloroethene	U	29	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	2	U	U
4-Chloroaniline	U	U	U	U	U
Phenol	U	U	7	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
Di-n-octylphthalate	U	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	U
Pyrene	U	U	U	U	U
Dimethylphthalate	170	U	U	U	U
Fluoranthene	U	U	U	U	U
Propanil	U	U	64	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	U	U	U	U	U
Dinoseb	26,000	6,300	U	18,000	45
2-Methyphenol	U	U	2	U	U
1,2-Dichlorobenzene	U	U	U	U	U
3,4-Dichloroaniline	U	U	12	U	U
<b>Pesticides (ppb)</b>					
Heptachlor Epoxide	U	U	U	U	U
Endosulfan Sulfate	U	U	U	U	U
Aldrin	U	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
delta-BHC	U	U	U	U	U
Endosulfan II	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
alpha-Chlordane	U	U	U	U	U
gamma-Chlordane	U	U	U	U	U
Endrin Ketone	U	U	U	U	U
Lindane	U	U	U	U	U
Dieldrin	U	6	U	U	U
Endrin	U	U	U	U	U
Methoxychlor	U	460	U	U	U
4,4'-DDD	U	U	U	U	U
4,4'-DDE	U	U	U	U	U
Heptachlor	U	U	U	U	U
Toxaphene	U	U	U	U	U
Endosulfan I	U	U	U	U	U
<b>Metals (ppm)</b>					
Lead	11	30	11	9	11
Arsenic	7	9	16	6	1
Silver	U	U	U	U	U
Barium	96	218	95	112	109
Cadmium	U	U	U	U	U
Chromium	13	12	15	11	12
Mercury	U	U	U	U	U

**Notes:**

U Not detected above PQLs



Table 5-11  
Cedar Chemical  
Phase II Facility Investigation  
Site 4 Soil Data

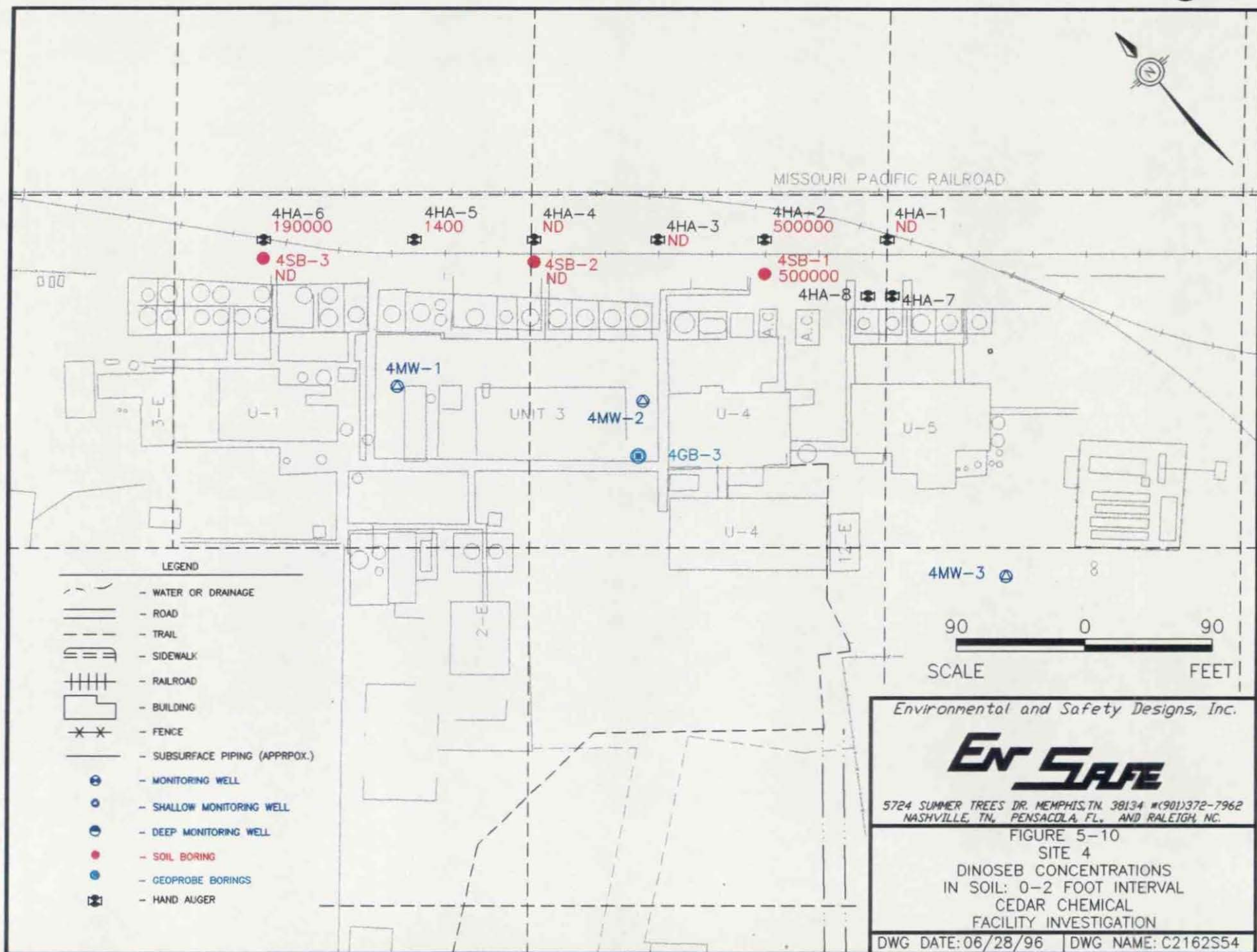
<i>Compounds Detected</i>													
Compound	Volatiles (ppb)						Semivolatiles (ppb)		Pesticides (ppb)				
	1,2-Dichloroethane	2-Butanone	Acetone	Ethylbenzene	Toluene	Xylene (total)	Isophorone	Dinoseb	4,4'-DDD	4,4'-DDE	4,4'-DDT	Methoxychlor	Dieldrin
4SB-1 (0-2')	10	130	250	13	32	U	U	550,000	U	U	U	8,700	U
4SB-1 (4-6')	U	U	150	U	28	U	U	360,000	U	U	U	U	U
4SB-1 (8-10')	U	U	4,400	U	U	U	U	U	U	U	U	U	U
4SB-2 (0-2')	U	U	U	U	U	U	U	U	350	250	U	120	U
4SB-2 (12-14')	U	U	U	U	U	U	8,800	U	U	U	U	U	U
4MW-3 (0-3')	U	U	U	U	U	U	U	U	U	22	100	220	U
4MW-3 (28-33')	340	U	U	U	U	U	U	U	U	U	U	U	U
4MW-4 (0-3')	U	U	U	U	8	U	U	95,000	29	23	55	6,800	480
4MW-4 (0-3') *	U	U	U	U	6	U	U	90,000	23	21	44	8,900	430
4MW-4 (8-13')	U	U	190	U	U	U	U	50,000	U	U	U	U	U
4MW-4 (18-23')	49	U	1,000	U	U	U	U	U	U	U	U	U	U
4MW-4 (23-28')	U	U	U	U	U	U	U	U	U	U	U	U	U
4SB-3 (0-2')	U	U	U	U	U	U	U	U	U	U	U	3,100	U
4SB-3 (6-8')	U	U	U	U	U	U	15,000	U	U	U	U	U	U
4SB-3 (12-14')	820	U	330	U	U	U	U	U	U	U	U	U	U

*Notes:*

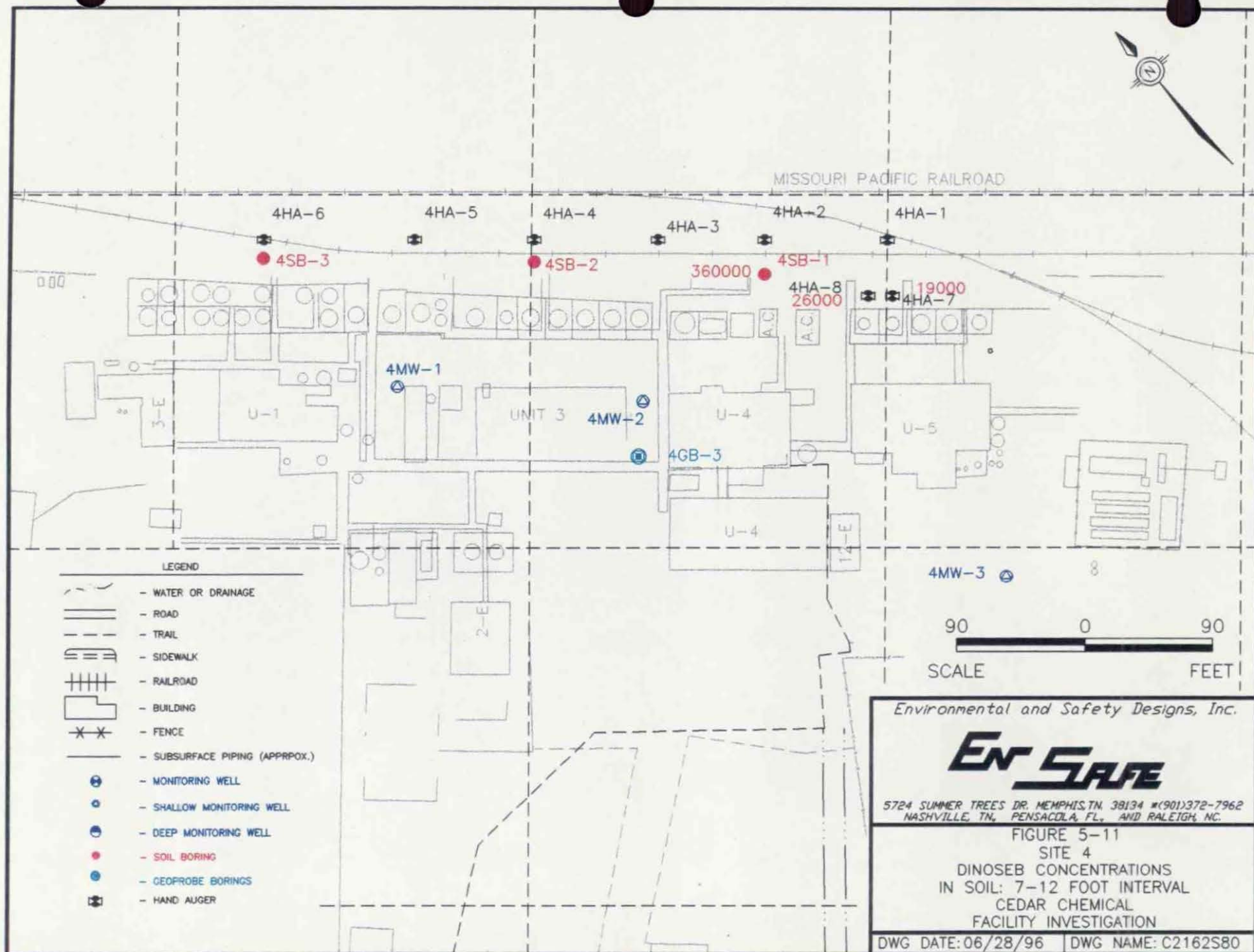
U Not quantified above PQLs

\* Duplicate Sample











## **5.6 Site 5 Soil Contamination**

### **Phase I**

Site 5 was sampled to determine if the contents of the drums in the vault beneath the N-5 Maintenance Services building had leaked into the soil. Three soil borings were installed at a 45° angle beneath the building and two soil samples were collected from each boring. Samples from 5SB-1 and 5SB-2 were collected at approximately 9.5 feet bgs and 12.5 feet bgs. Samples from boring 5SB-3 were collected at approximately 9.5 feet bgs and 14 feet bgs. The contaminant concentrations detected in the Site 5 soil samples are shown in Table 5-12.

Based on the results of the Phase I investigation, it was determined that dinoseb concentrations detected in boring 5SB-2 most likely result from soil contamination associated with Site 9, not Site 5. Therefore, no additional sampling was conducted.

## **5.7 Site 6 Soil Contamination**

### **Phase I**

Site 6, which primarily consists of the unoccupied areas of the site, was divided into grids and sampled to determine the full extent of soil contamination, particularly dinoseb, across the facility. Ten locations were selected for sampling at depths of 0 to 5 feet bgs and 5 to 10 feet bgs. Prior to the initiation of the Phase I sampling, five soil borings were installed and sampled in the employee parking lot. Interim Measure (IM) sampling was performed to determine if significant contamination existed prior to parking lot construction. IM soil samples are identified as IMSB-1, etc.

Soil samples were analyzed for VOCs, SVOCs, pesticides, and metals. Table 5-13 presents the results of the Site 6 soil samples. Table 5-14 lists the IM soil data.



**Table 5-12**  
**Cedar Chemical**  
**Phase 1 Facility Investigation**  
**Site 5 Soil Data**

Compound	5SB-1 (16-18')	5SB-1 (21-23')	5SB-2 (16-18')	5SB-2 (21-23')	5SB-3 (16-18')	5SB-3 23-25')
<b>Volatiles (ppb)</b>						
Ethylbenzene	U	U	3	U	U	U
1,2-Dichloroethane	U	U	U	U	U	4
4-Methyl-2-Pentanone	U	U	35	U	1	170
Toluene	U	U	210	300	U	6
Total Xylenes	U	20	31	U	U	6
Acetone	U	U	6,800	3,900	U	21,000
Chloroform	U	U	U	U	U	4
Methylene Chloride	18	140	8	U	21	33
2-Butanone	U	U	21,000	44,000	U	120
<b>Semivolatiles (ppb)</b>						
2,4-Dinitrophenol	U	U	23,000	49,000	U	U
4,6-Dinitro-2-methylphenol	U	U	200	U	U	U
Dinoseb	U	U	170,000	57,000	U	U
3,4-Dichloroaniline	U	1,200	U	U	U	U
<b>Pesticides (ppb)</b>						
alpha-BHC	U	U	4	7	U	U
Endosulfan II	U	U	12	6	U	U
Lindane	U	U	U	6	U	U
<b>Metals (ppm)</b>						
Lead	8	10	9	8	10	10
Arsenic	7	9	8	8	9	10
Barium	129	147	168	134	126	141
Cadmium	U	U	U	U	U	0
Chromium	10	11	12	10	9	10

*Note:*

U Not quantified above PQLs



Table 5-13  
Cedar Chemical  
Phase I Facility Investigation  
Site 6 Soil Data

Compound	6SB-A (-5')	6SB-A (5-10')	6SB-C (0-5')	6SB-C (5-10')	6SB-D (0-5')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	U
1,2-Dichloroethane	U	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	2	U
Toluene	U	U	U	U	U
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U
Total Xylenes	U	U	U	U	U
2-Hexanone	U	U	U	U	U
Acetone	53	U	5	U	8
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	14	23	20
2-Butanone	U	U	U	U	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	90	110
Propanil	U	U	700	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	U	98	U	U	U
Dinoseb	9,500	430	14,000	U	6,100
3,4-Dichloroaniline	U	U	230	U	U
<b>Pesticides (ppb)</b>					
Aldrin	4	U	U	U	U
alpha-BHC		U	3	U	U
beta-BHC	7	U	U	U	U
4,4'-DDT	58	U	U	U	U
Dieldrin	30	6	U	U	U
Methoxychlor	U	U	U	U	U
4,4'-DDD	U	U	U	U	U
4,4'-DDE	26	U	U	U	U
<b>Metals (ppm)</b>					
Lead	14	13	9	11	11
Arsenic	7	10	6	10	7
Barium	251	398	93	187	123
Cadmium	U	U	U	0	U
Chromium	15	10	11	10	14

*Notes:*

U Not detected above PQLs



Table 5-13  
Cedar Chemical  
Phase I Facility Investigation  
Site 6 Soil Data

Compound	6SB-D (5-10')	6SB-E (0-5')	6SB-E (5-10')	6SB -F (0-5')	6SB-F (5-10')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	2	6
1,2-Dichloroethane	9	U	U	U	U
4-Methyl-2-Pentanone	500	U	U	U	1
Toluene	U	U	U	2	10
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U
Total Xylenes	U	U	U	8	43
2-Hexanone	U	U	U	U	3
Acetone	860	67	31	U	240
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	14
2-Butanone	49	U	U	U	93
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	8,100	U
Phenol	6,900	U	U	U	U
Bis-(2-ethylhexyl)phthalate	104	U	U	U	U
Propanil	910	U	103	1,300	18,000
Isophorone	4,500	U	U	U	U
Di-n-butylphthalate	U	U	U	U	U
Dinoseb	U	U	10,000	16,000	21,000
3,4-Dichloroaniline	610	84	U	U	4,900
<b>Pesticides (ppb)</b>					
Aldrin	U	18	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
4,4'-DDT	U	21	U	U	U
Dieldrin	U	9	U	U	U
Methoxychlor	U	510	3,400	U	U
4,4'-DDD	U	28	U	U	U
4,4'-DDE	U	9	U	10	U
<b>Metals (ppm)</b>					
Lead	9	10	11	12	11
Arsenic	7	9	8	7	6
Barium	144	126	134	164	152
Cadmium	U	U	U	U	U
Chromium	9	10	12	9	13

*Notes:*

U Not detected above PQLs



Table 5-13  
Cedar Chemical  
Phase I Facility Investigation  
Site 6 Soil Data

Compound	6SB- G (0-5')	6SB- G (5-10')	6 SB- H (0-5')	6SB-H (5-10')	6SB-J (5-10')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	U
1,2-Dichloroethane	U	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	U	U
Toluene	U	U	U	U	U
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U
Total Xylenes	U	U	U	U	U
2-Hexanone	U	U	U	U	U
Acetone	890	15	37	U	55
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	U	U	U	U	U
2-Butanone	U	U	U	3	U
<b>Semivolatiles (ppb)</b>					
4-Nitrophenol	U	U	U	U	U
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
Propanil	U	U	U	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	200	170	102	U	U
Dinoseb	45,000	5,300	7,700	10,200	1,000
3,4-Dichloroaniline	1,600	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	U	U	U
alpha-BHC	U	4	U	U	3
beta-BHC	U	U	U	U	U
4,4'-DDT	U	U	200	190	U
Dieldrin	U	U	U	U	U
Methoxychlor	U	U	U	U	U
4,4'-DDD	U	U	U	U	16
4,4'-DDE	U	U	48	46	4
<b>Metals (ppm)</b>					
Lead	10	12	9	11	13
Arsenic	7	7	5	6	8
Barium	101	103	103	86	127
Cadmium	U	U	U	U	U
Chromium	11	13	9	14	12

*Notes:*

U Not detected above PQLs



Table 5-13  
Cedar Chemical  
Phase I Facility Investigation  
Site 6 Soil Data

Compound	6SB-J (10-15')	6SB-K (0-5')	6SB-K (5-10')	6SB-L (0-5')	6SB-L (5-10')
<b>Volatiles (ppb)</b>					
Ethylbenzene	U	U	U	U	U
1,2-Dichloroethane	9	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	U	U
Toluene	U	U	U	U	U
Chlorobenzene	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U
Total Xylenes	U	U	U	U	U
2-Hexanone	U	U	U	U	U
Acetone	U	180	25	27	U
Chloroform	U	U	U	U	U
Benzene	U	U	U	U	U
Methylene Chloride	10	U	24	U	41
2-Butanone	U	U	U	U	U
Semivolatiles (ppb)	U	U	U	U	U
4-Nitrophenol	U	U	U	U	U
Phenol	U	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U	U
Propanil	U	U	U	U	U
Isophorone	U	U	U	U	U
Di-n-butylphthalate	150	U	200	U	U
Dinoseb	U	4,100	1,060	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	240	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
Dieldrin	U	U	U	U	U
Methoxychlor	U	98,000	U	U	U
4,4'-DDD	U	U	U	U	28
4,4'-DDE	U	U	U	U	23
<b>Metals (ppm)</b>					
Lead	12	12	13	7	11
Arsenic	7	9	9	6	6
Barium	150	115	108	111	79
Cadmium	U	0	U	U	U
Chromium	10	11	12	10	15

*Notes:*

U Not detected above PQLs



Table 5-14  
Cedar Chemical  
Phase I Facility Investigation  
Interim Measure Data

Compound	IMSB-1 (1-3')	IMSB-1 (3-8')	IMSB-1 (8-12')	IMSB-2 (1-5')	IMSB-2 (5-10')
<b>Volatiles (ppb)</b>					
1,2-Dichloroethane	U	U	NA	U	U
Toluene	U	U	NA	U	9
Acetone	U	200	NA	240	320
Methylene Chloride	U	U	NA	U	U
<b>Semivolatiles (ppb)</b>					
Phenol	U	U	U	U	U
Propanil	U	U	U	U	U
Dinoseb	U	63,000	U	U	2,900
3,4-Dichloroaniline	U	U	U	U	6,700
<b>Pesticides (ppb)</b>					
Aldrin	420	U	U	U	U
alpha-BHC	U	U	U	U	U
beta-BHC	U	U	U	U	10
delta-BHC	U	U	26	U	U
4,4'-DDT	890	U	U	55	U
Lindane	U	3	U	U	U
Dieldrin	U	U	U	7	U
Endrin	250	U	U	U	U
Methoxychlor	U	U	U	600	U
4,4'-DDD	U	U	U	U	U
4,4'-DDE	190	U	U	U	U
Heptachlor	U	U	U	U	31
<b>Metals (ppb)</b>					
Lead	13	12	NA	7	12
Arsenic	59	9	NA	3	7
Barium	313	143	NA	82	210
Chromium	12	9	NA	8	10
Selenium	0	0	NA	U	0

**Notes:**

U Not quantified above PQLs



Table 5-14  
Cedar Chemical  
Phase I Facility Investigation  
Interim Measure Data

Compound	IMSB-2 (10-15')	IMSB-3 (1-5')	IMSB-3 (5-10')	IMSB-3 (10-15')	IMSB-4 (1-5')
<b>Volatiles (ppb)</b>					
1,2-Dichloroethane	10	U	U	NA	U
Toluene	U	U	U	NA	U
Acetone	U	U	U	NA	U
Methylene Chloride	66		12	NA	U
<b>Semivolatiles (ppb)</b>					
Phenol	U	U	1,000	U	U
Propanil	8,800	U	U	U	U
Dinoseb	U	U	12,000	U	U
3,4-Dichloroaniline	U	U	2,600	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	U	9	U	U
alpha-BHC	55	U	U	U	U
beta-BHC	U	U	37	U	U
delta-BHC	U	U	U	U	U
4,4'-DDT	U	U	U	U	U
Lindane	U	U	3	U	U
Dieldrin	350	U	U	U	56
Endrin	U	U	U	U	U
Methoxychlor	U	U	U	U	U
4,4'-DDD	U	U	10	U	U
4,4'-DDE	U	U	U	U	U
Heptachlor	U	U	5	U	U
<b>Metals (ppm)</b>					
Lead	NA	9	13	NA	10
Arsenic	NA	7	7	NA	9
Barium	NA	130	231	NA	130
Chromium	NA	13	14	NA	14
Selenium	NA	U	0	NA	U

**Notes:**

U Not quantified above PQLs

NA Laboratory did not analyzed for that method



**Table 5-14**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Interim Measure Data**

Compound	IMSB-4 (5-10')	IMSB-4 (10-15')	IMSB-5 (1-5')	IMSB-5 (5-10')	IMSB-5 (10-15')
<b>Volatiles (ppb)</b>					
1,2-Dichloroethane	U	NA	U	U	NA
Toluene	U	NA	U	U	NA
Acetone	U	NA	U	U	NA
Methylene Chloride	U	NA	U	U	NA
<b>Semivolatiles (ppb)</b>					
Phenol	U	U	U	U	U
Propanil	U	U	U	U	U
Dinoseb	U	U	U	U	U
3,4-Dichloroaniline	U	U	U	U	U
<b>Pesticides (ppb)</b>					
Aldrin	U	NA	U	U	NA
alpha-BHC	U	NA	U	U	NA
beta-BHC	U	NA	U	U	NA
delta-BHC	U	NA	U	U	NA
4,4'-DDT	U	NA	U	U	NA
Lindane	U	NA	U	U	NA
Dieldrin	U	NA	13	U	NA
Endrin	U	NA	U	U	NA
Methoxychlor	U	NA	U	U	NA
4,4'-DDD	U	NA	U	U	NA
4,4'-DDE	U	NA	U	U	NA
Heptachlor	U	NA	U	U	NA
<b>Metals (ppm)</b>					
Lead	13	NA	11	10	NA
Arsenic	9	NA	10	7	NA
Barium	156	NA	146	122	NA
Chromium	17	NA	12	12	NA
Selenium	0	NA	0	0	NA

*Notes:*

U Not quantified above PQLs

NA Laboratory did not analyzed for that method



## **Phase II**

To facilitate a health-based risk assessment, 15 soil samples were collected with a stainless-steel hand auger from 0 to 1 foot bgs at Site 6 during Phase II of the investigation. Samples were analyzed for SVOCs and pesticides. The data generated will be used to identify site contaminants and develop risk-based, site-specific cleanup concentrations. The results are provided in Table 5-15. Isopleths for total VOCs, SVOCs, and pesticides at various depths are presented in Figures 5-12, 5-13, 5-14, 5-15, 5-16, 5-17, 5-18, and 5-19.

### **5.8 Site 8 Soil Contamination**

Four soil samples were collected from the Site 8 ditch. All Site 8 samples were analyzed for VOCs, SVOCs, pesticides, and metals. The results are presented in Table 5-16.

### **5.9 Site 9 Soil Contamination**

#### **Phase I**

Site 9 was sampled to confirm the existence of the former dinoseb disposal ponds, and if identified, to delineate the lateral extent of the potential associated contamination. During Phase I, 19 soil borings were installed and sampled. All soil samples were screened onsite at the Cedar Chemical laboratory for the presence of dinoseb. Split samples were subsequently submitted to the contract laboratory for SVOC analysis and samples from soil borings 9SB-3 and 9SB-15 were analyzed for VOCs, SVOCs, pesticides, and metals. Contaminant concentrations in the Site 9 soils reported by the contract laboratory are presented in Tables 5-17 and 5-18.

Based on the distribution and concentrations of dinoseb detected during Phase I, the ponds were assumed to be sufficiently delineated laterally, as shown in Figures 5-20, 5-21, and 5-22. However, the vertical extent of the dinoseb contamination was not delineated.



Table 5-15  
Cedar Chemical  
Phase II Facility Investigation  
Site 6 Soil Data

<i>Compounds Detected</i>											
Semivolatiles (ppb)			Pesticides (ppb)								
Benzo(a)Anthracene	Chrysene	Dinoseb	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Dieldrin	Endrin	Methoxychlor	Toxaphene	
6HA-B1 (0-1')	870	870	160,000	U	U	U	U	U	34	5,000	U
6HA-B2 (0-1')	U	U	5,600	150	27	U	15	U	U	240	U
6HA-C1 (0-1')	U	U	110,000	25	U	U	U	26	U	9,200	14,000
6HA-C2 (0-1')	U	U	5,600	47	U	U	24	78	U	1,300	U
6HA-D1 (0-1')	U	U	9,100	U	25	190	U	U	22	1,500	U
6HA-F1 (0-1')	U	U	3,800	46	U	44	17	36	U	300	U
6HA-F2 (0-1')	U	U	U	U	U	U	U	U	U	170	U
6HA-G1 (0-1')*	U	U	U	U	U	U	U	U	U	300	U
6HA-G1 (0-1')	U	U	U	U	U	U	U	U	U	350	U
6HA-G2 (0-1')	U	U	2,200	U	U	U	U	U	U	2,500	U
6HA-H1 (0-1')	U	U	U	120	73	58	U	U	U	U	U
6HA-H2 (0-1')	U	U	U	U	U	U	U	18	U	340,000	U
6HA-J1 (0-1')	U	U	2,900	31	U	27	14	42	U	420	U
6HA-K1 (0-1')	U	U	960	U	U	U	U	44	U	820	U
6HA-L1 (0-1')	U	U	U	84	64	140	5	29	63	210	2,500

*Notes:*

U Not quantified above PQLs

\* Duplicate Sample



Table 5-16  
Cedar Chemical  
Phase I Facility Investigation  
Site 8 Soil Data

Compound	CED1SHA6	CED1HA7	CED1HA8	CED1HA9
<b>Volatiles (ppb)</b>				
Ethylbenzene	U	U	U	U
1,2-Dichloroethane	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	U
Toluene	U	U	U	U
Chlorobenzene	U	U	U	U
Tetrachloroethene	U	U	U	U
Total Xylenes	U	U	U	U
2-Hexanone	U	U	U	U
Acetone	U	U	U	U
Chloroform	U	U	U	U
Benzene	U	U	U	U
Methylene Chloride	U	U	U	U
2-Butanone	U	U	U	U
<b>Semivolatiles (ppb)</b>				
4-Methylphenol	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U
Pyrene	U	U	U	U
Di-n-butylphthalate	U	U	U	U
Dinoseb	U	U	U	U
Bis-(2-ethylhexyl)phthalate	U	U	U	U
3,4-Dichloroaniline	U	U	U	U
<b>Pesticides (ppb)</b>				
Endosulfan Sulfate	U	U	U	U
Aldrin	U	U	U	U
beta-BHC	U	U	U	U
delta-BHC	U	U	U	U
4,4'-DDT	U	U	U	U
gamma-Chlordane	U	U	U	U
Lindane	U	U	U	U
Dieldrin	U	4	U	U
4,4'-DDD	U	U	U	U
4,4'-DDE	U	U	U	U
<b>Metals (ppm)</b>				
Lead	12.1	9.4	11.8	12.5
Arsenic	6.1	4.2	5.2	6.3
Silver	U	U	U	U
Barium	248	142	77.6	157
Cadmium	U	U	U	U
Chromium	22.9	18.7	21.7	16.5
Mercury	U	U	U	U

Note:

U Not detected above PQLs



Table 5-17  
Cedar Chemical  
Phase I Facility Investigation  
Site 9 Soil Data

*Compounds Detected*

Sample	Semivolatiles (ppb)			
	2,4-Dinitrophenol	Propanil	Dinoseb	3,4-Dichloroaniline
9SB-1 (0-5')	U	U	38,000	U
9SB-1 (5-10')	U	310	9,600	U
9SB-2 (5-10')	3,400	150	1,600	U
9SB-3 (0-5')	U	11,000	140,000	76,000
9SB-3 (5-10')	U	U	U	130
9SB-4 (0-5')	U	4,000,000	24,000,000	U
9SB-4 (5-10')	U	U	8,500,000	U
9SB-4 (10-15')	U	U	550,000	U
9SB-5 (0-5')	U	U	29,000,000	U
9SB5 (5-10')	U	U	4,100,000	U
9SB-5 (10-15')	U	U	1,700,000	U
9SB-6 (0-5')	U	56,000	U	19,000
9SB-6 (5-10')	U	8,600	U	U
9SB-7 (0-5')	U	770,000	26,000,000	450,000
9SB-7 (5-10')	U	U	6,400,000	U
9SB-7 (10-15')	U	U	360,000	U
9SB-8 (0-5')	U	U	15,000,000	U
9SB-8 (5-10')	U	U	13,000	U
9SB-9 (0-5')	U	U	28,000,000	U
9SB-9 (5-10')	U	U	90,000	U
9SB-10 (0-5')	U	U	650,000	U
9SB-10 (5-10')	U	U	40,000	U
9SB-11 (0-5')	U	U	160,000	U
9SB-11 (5-10')	U	41,000	170,000	U
9SB-12 (0-5')	U	U	13,000,000	U
9SB-12 (5-10')	U	U	320,000	U
9SB-13 (0-5')	U	U	150,000	U
9SB-13 (5-10')	U	U	34,000	U
9SB-14 (0-5')	U	860	9,100	U
9SB-14 (5-10')	U	3,300	35,000	U
9SB-15 (0-5')	U	U	8,600	150
9SB-15 (5-10')	U	U	22,000	U
9SB-16 (0-5')	U	U	U	U
9SB-16 (5-10')	U	U	9,200	U
9SB-18 (0-5')	U	U	93,000	16,000
9SB-18 (5-10')	U	1,300	17,000	1,300
9SB-19 (0-5')	U	U	U	U
9SB-19 (5-10')	U	U	U	U

*Notes:*

U Not detected above PQLs



**Table 5-18**  
**Cedar Chemical**  
**Phase I Facility Investigation**  
**Site 9 Soil Data**

Compound	9SB-3 (0-5')	9SB-3 (5-10')	9SB-15 (0-5')	9SB-15 (5-10')
<b>Volatiles (ppb)</b>				
4-Methyl-2-Pentanone	12	19	U	U
Total Xylenes	4	U	U	U
Acetone	300	1,200	U	U
2-Butanone	22	U	U	U
<b>Semivolatiles (ppb)</b>				
2,4-Dinitrophenol	U	U	U	U
Propanil	11,000	U	U	U
Dinoseb	140,000	U	8,600	22,000
3,4-Dichloroaniline	76,000	130	150	U
<b>Pesticides (ppb)</b>				
4,4'-DDT	U	U	15	U
4,4'-DDD	U	U	24	U
4,4'-DDE	U	U	12	U
Heptachlor	150	U	U	U
<b>Metals (ppm)</b>				
Lead	9	11	8	10
Arsenic	4	7	3	7
Barium	100	150	94	133
Chromium	15	13	11	11

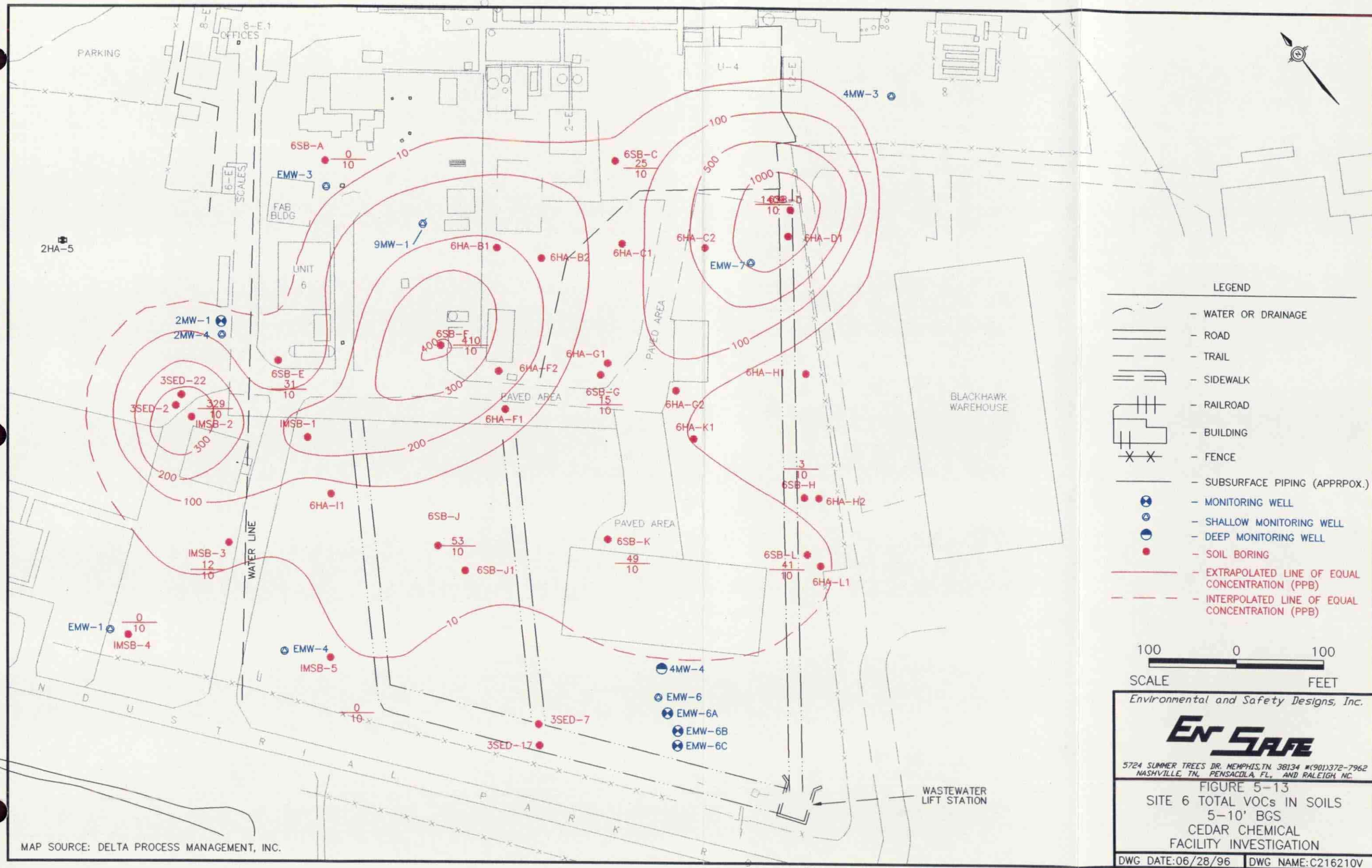
*Note:*

U Not quantified above PQLs

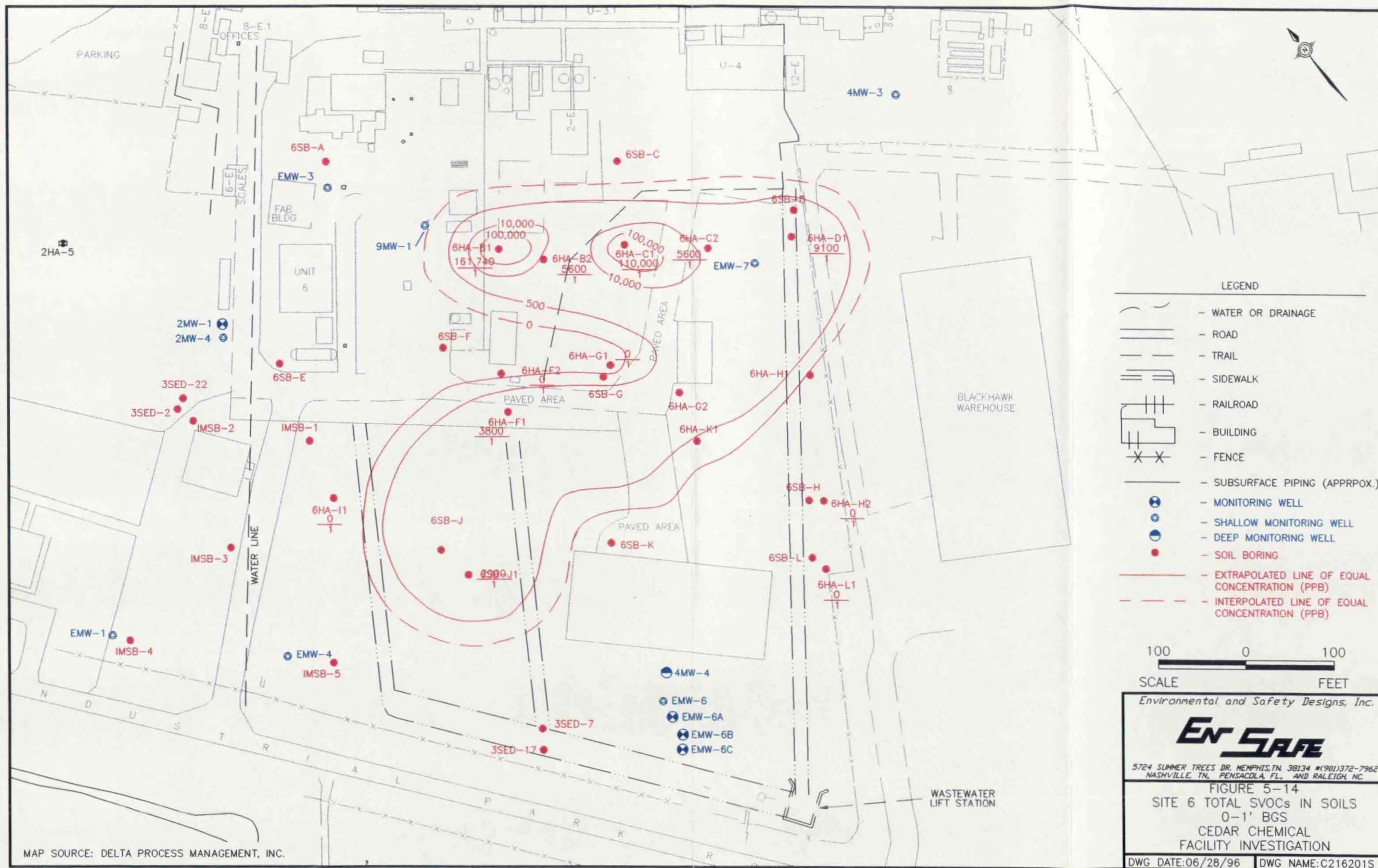




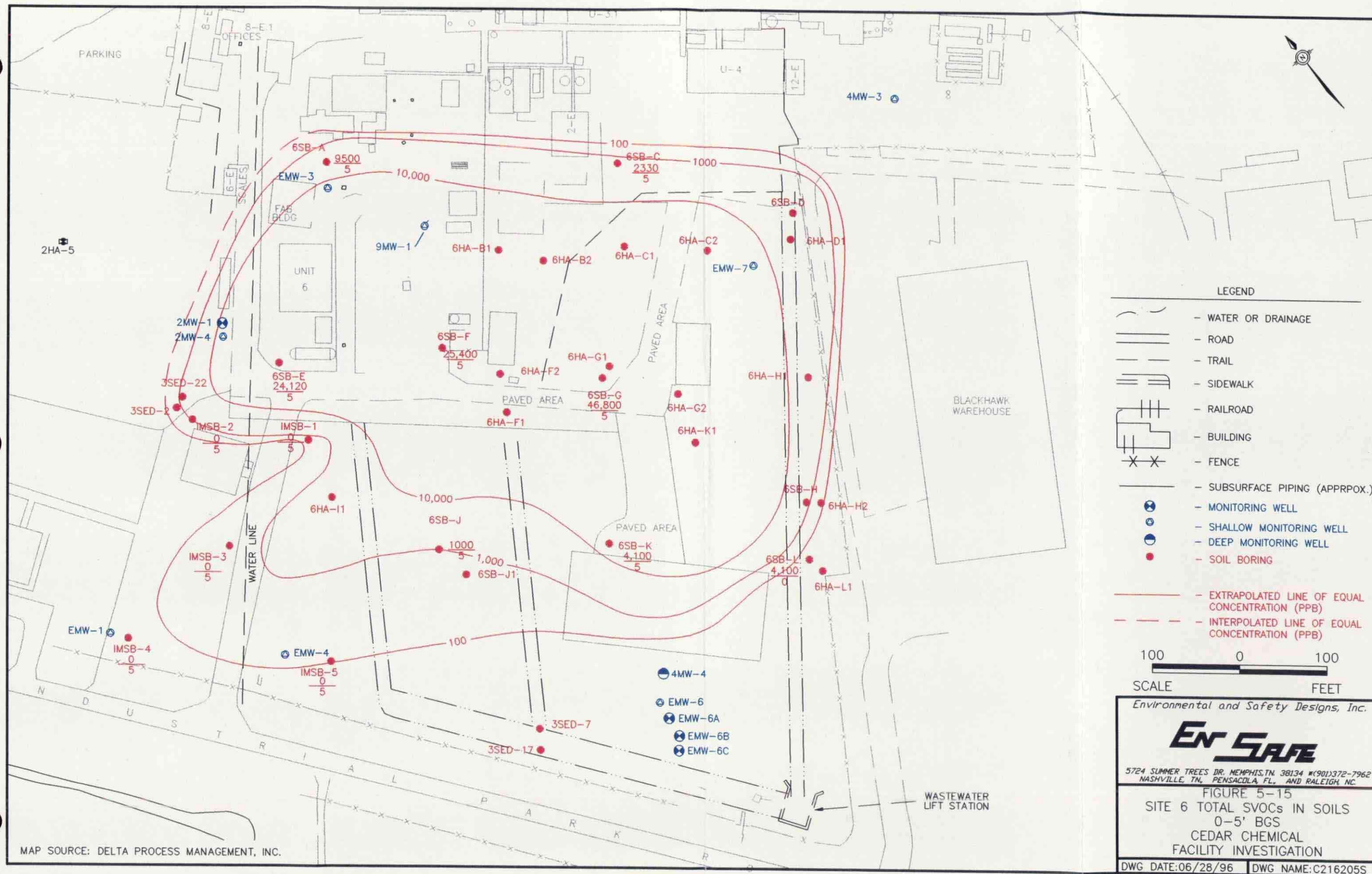






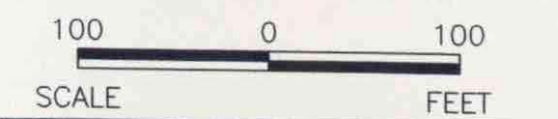






**LEGEND**

- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- SOIL BORING
- EXTRAPOLATED LINE OF EQUAL CONCENTRATION (PPB)
- INTERPOLATED LINE OF EQUAL CONCENTRATION (PPB)



Environmental and Safety Designs, Inc.

**EN SAFE**

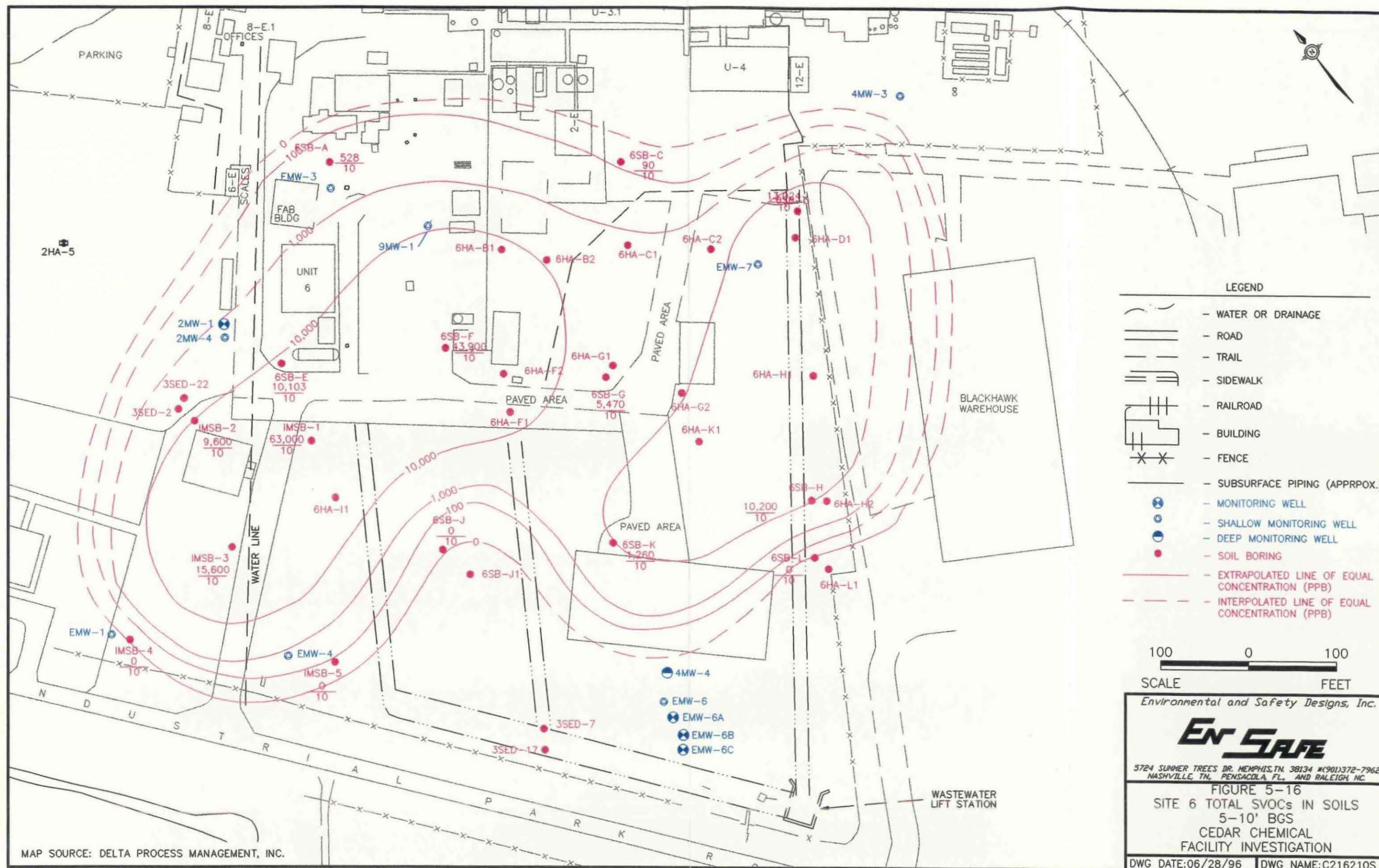
5724 SUMMER TREES DR. MEMPHIS, TN 38134 (901)372-7962  
NASHVILLE, TN, PENSACOLA, FL, AND RALEIGH, NC.

FIGURE 5-15  
SITE 6 TOTAL SVOCs IN SOILS  
0-5' BGS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162055

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.





- LEGEND
- WATER OR DRAINAGE
  - ROAD
  - TRAIL
  - SIDEWALK
  - RAILROAD
  - BUILDING
  - FENCE
  - SUBSURFACE PIPING (APPROX.)
  - MONITORING WELL
  - SHALLOW MONITORING WELL
  - DEEP MONITORING WELL
  - SOIL BORING
  - EXTRAPOLATED LINE OF EQUAL CONCENTRATION (PPB)
  - INTERPOLATED LINE OF EQUAL CONCENTRATION (PPB)

100 0 100  
SCALE FEET

Environmental and Safety Designs, Inc.

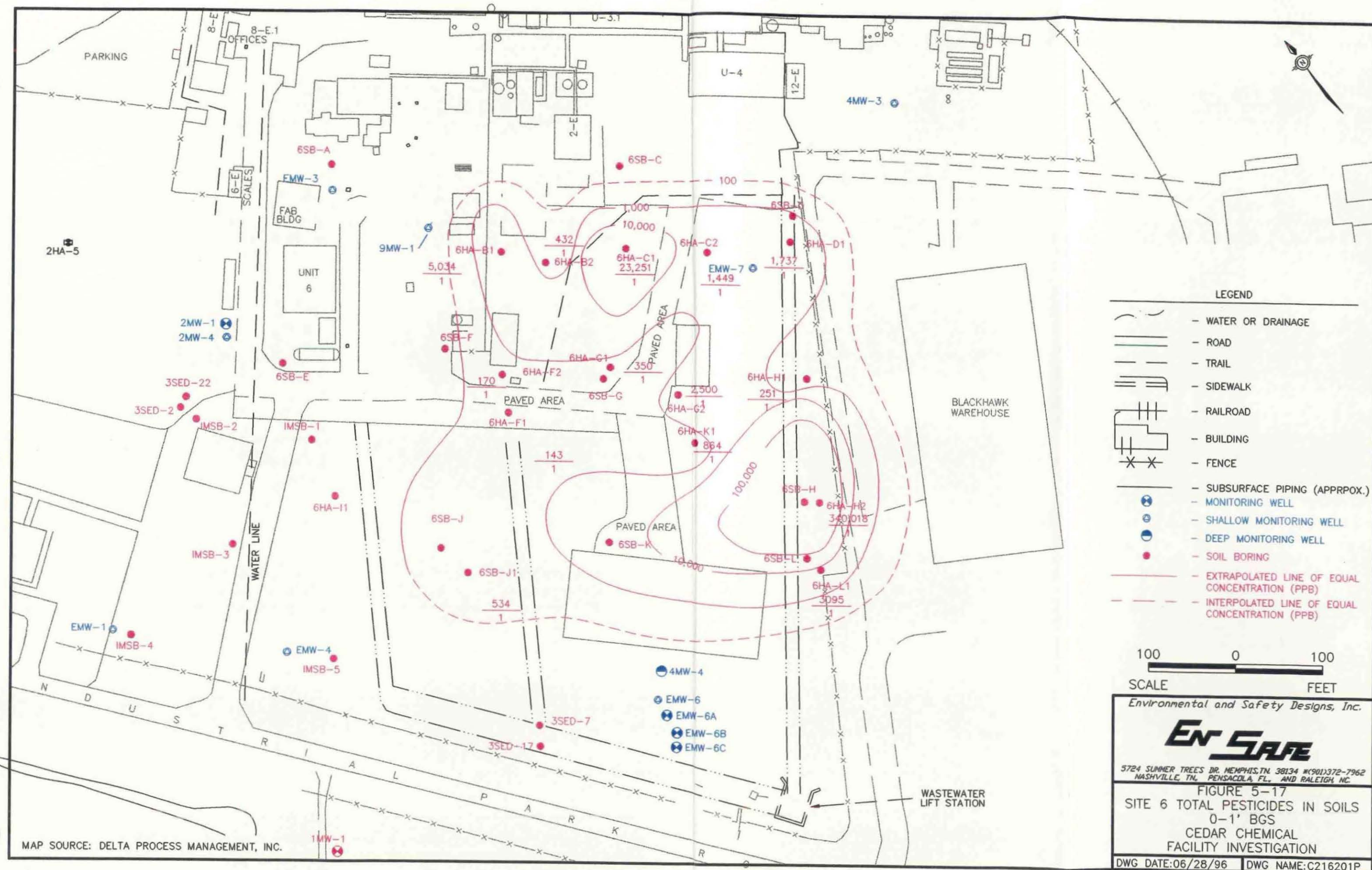
**EN SAFE**

5724 SUMMER TREES DR. MEMPHIS, TN 38134 (901) 372-7962  
NASHVILLE, TN, PENSACOLA, FL, AND RALEIGH, NC.

FIGURE 5-16  
SITE 6 TOTAL SVOCs IN SOILS  
5-10' BGS  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162105

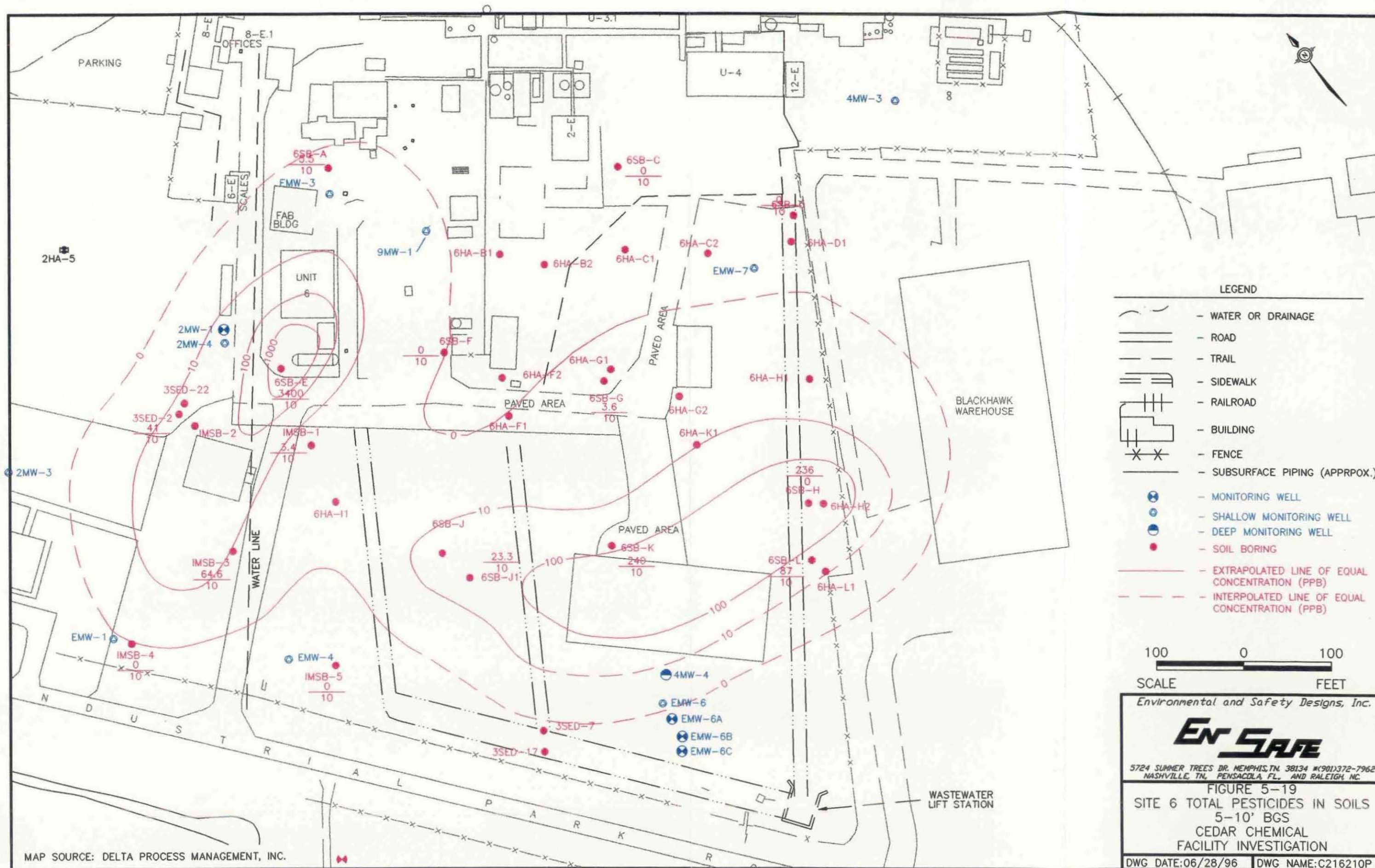




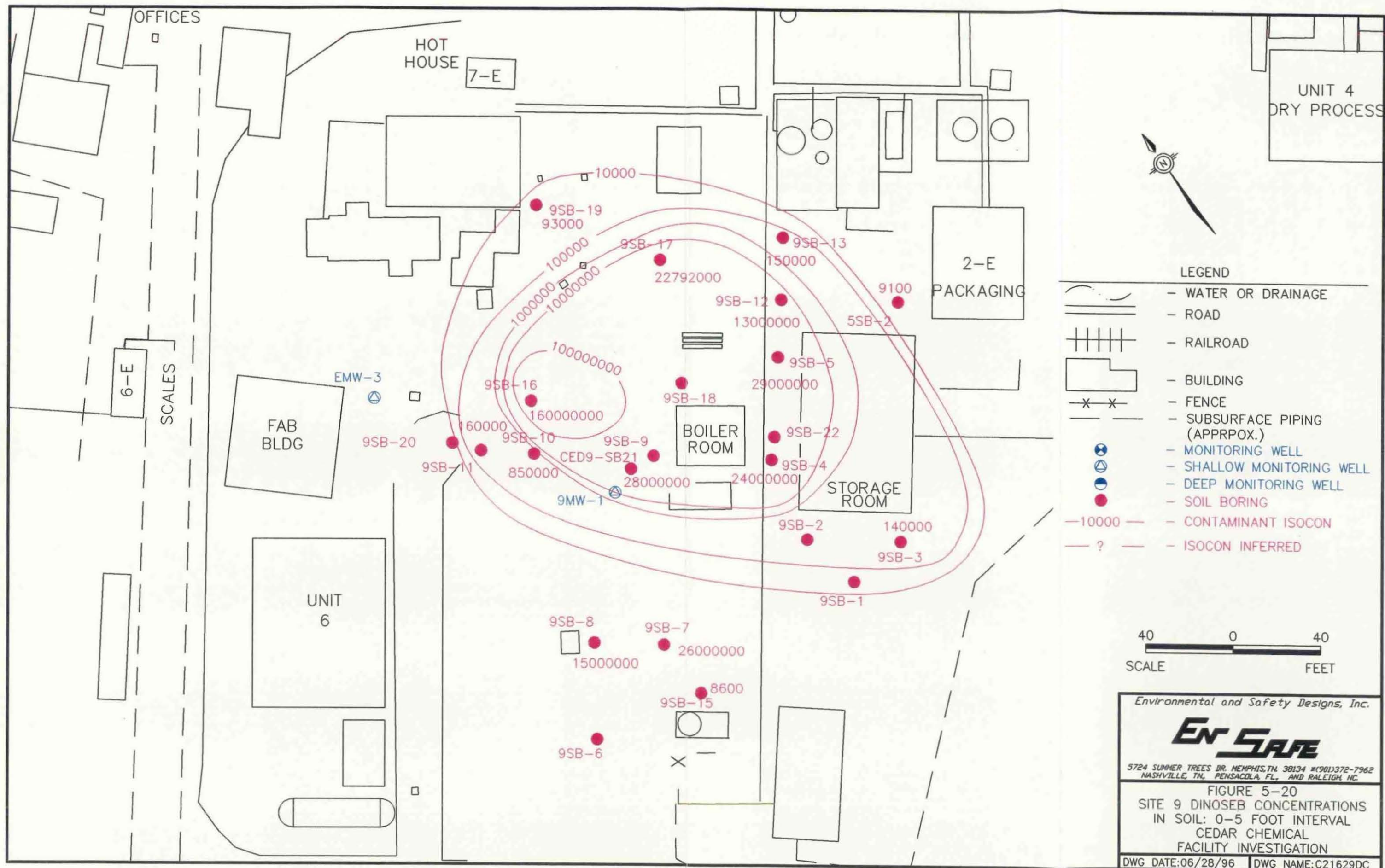




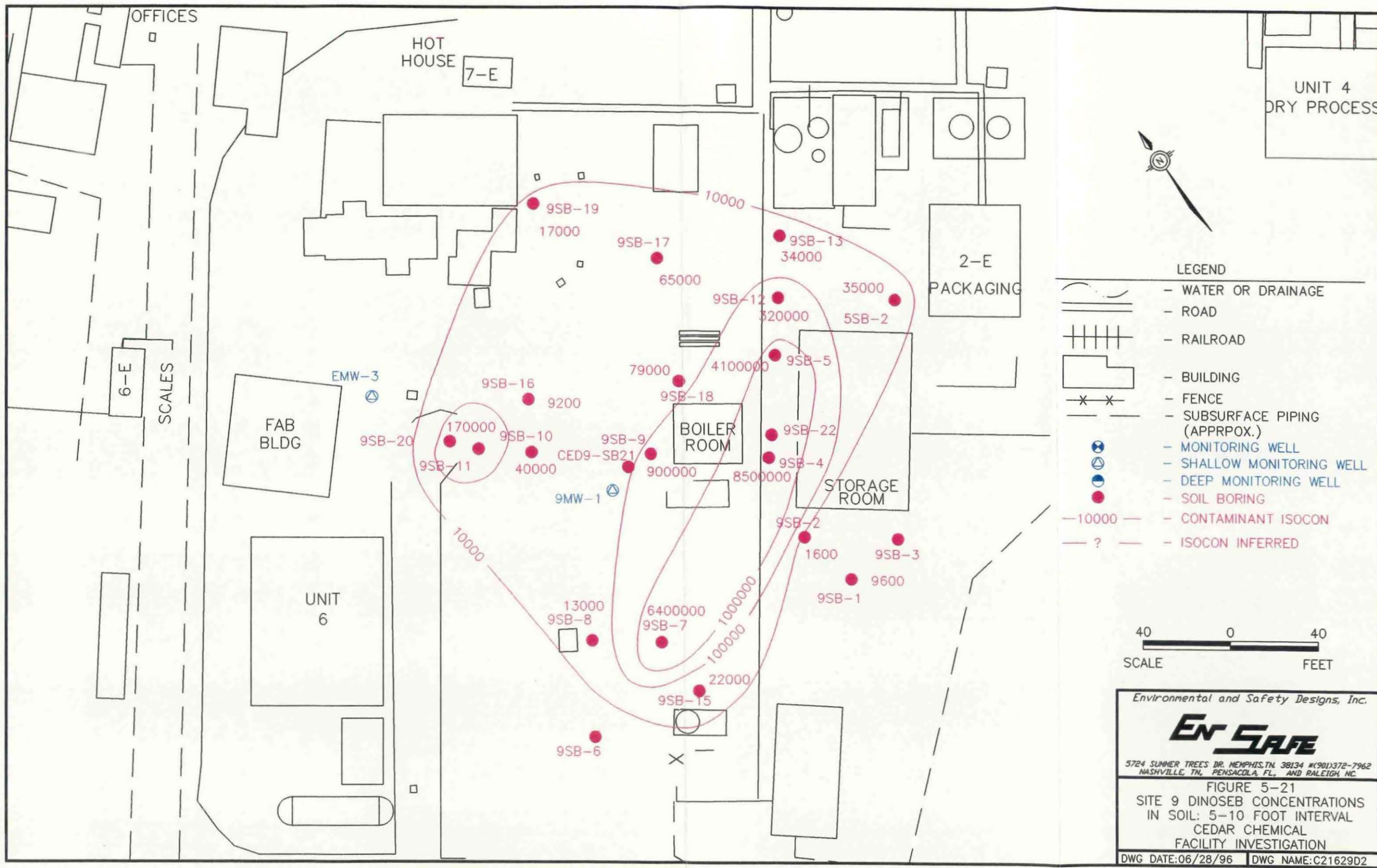














## **Phase II**

Proposed Phase II soil sampling at Site 9 consisted of installing one soil boring in each of the three areas exhibiting the highest dinoseb concentrations during Phase I. Samples were collected from 10 feet bgs until the alluvial aquifer was encountered to determine if the contaminants detected in the Phase I sampling extended to groundwater.

Dinoseb concentrations in these borings ranged from 500 ppb to 270,000 ppb. Analytical results are presented in Table 5-19.

### **5.10 Source Area Investigation Results**

Analytical data from the source area soil samples indicate two potential sources. The most heavily impacted area is southwest of Unit 4 and northeast of existing well EMW-7, which also is most heavily contaminated with 1,2-dichloroethane (84,000 ppb). The second, and less contaminated, source area appears to be around the southeastern side of Unit 5. The isopleth map presented in Figure 5-23 delineates two areas of high concentrations. The two oblong source areas appear to follow the path of the abandoned tile wastewater line leading from Unit 5. The estimated path of the line has been included on the figure.

Table 5-20 presents the source area soil screening results. Tables 5-21, 5-22 and 5-23 present the results of the split samples submitted to the contract laboratory. Also included in this table are results for samples suspected to contain constituents that would not be identified by the field GC. All samples but one submitted for confirmatory analysis exhibited detectable dinoseb concentrations.

### **5.11 Air Monitoring**

Ambient air monitoring was conducted during Phase III of the investigation. Five stations at the site were monitored for six days. Each station was sampled with an FID for approximately two minutes. The date, time, wind direction and speed, and concentration were recorded at every station during each monitoring event. Air monitoring results are presented in Table 5-24.



**Table 5-19**  
**Cedar Chemical**  
**Phase II Facility Investigation**  
**Site 9 Soil Data**

<i>Compounds Detected</i>									Semivolatiles (ppb)	
Volatiles (ppb)										
Sample	1,2-Dichloroethane	2-Butanone	Acetone	Methylene Chloride	Toluene	4-Methy-2-Pentanone	Ethylbenzene	Xylenes (total)	Dinoseb	
9SB-20 (10-12')	58	3,000	2,900	92	61	U	U	U	500	
9SB-20 (25-27')	730	2,100	4,300	840	960	U	U	U	U	
9SB-20 (30-32')	120	U	12,000	U	U	U	U	U	U	
9SB-21 (10-12')	43	1,700	800	94	U	U	U	U	42,000	
9SB-21 (23-25')	U	1,700	1,200	170	U	U	U	U	7,400	
9SB-21 (25-27')	U	2,400	1,400	U	U	U	U	U	690	
9SB-22 (10-12')	U	36,000	200,000	U	10	63	10	130	270,000	
9SB-22 (15-17')	U	6,700	44,000	U	U	U	U	140	880	
9SB-22 (17-19')	U	U	110	U	U	U	U	12	4,000	

*Notes:*

U Not quantified above PQLs



Table 5-20  
Field Screening Results  
for 1,2-Dichloroethane in Soil

Sample Number	Results (ppb)	Collection Date
SAI-1 (0 — 2')	<20	10/12/95
SAI-1 (2 — 4')	<20	10/12/95
SAI-1 (32 — 34')	6	10/12/95
SAI-2 (4 — 6')	120	10/13/95
SAI-2 (6 — 8')	64	10/12/95
SAI-2 (24 — 26')	35,000	10/13/95
SAI-2 (26 — 28')	31,000	10/12/95
SAI-3 (12 — 14')	<20	10/13/95
SAI-3 (28 — 30')	<20	10/13/95
SAI-4 (12 — 14')	<20	10/12/95
SAI-4 (28 — 30')	<20	10/12/95
SAI-5 (12 — 14')	110	10/12/95
SAI-5 (28 — 30')	18	10/12/95
SAI-6 (12 — 14')	21	10/16/95
SAI-6 (26 — 28')	220	10/16/95
SAI-7 (12 — 14')	<20	10/16/95
SAI-7 (28 — 30')	<20	10/16/95
SAI-8 (12 — 14')	<20	10/16/95
SAI-8 (28 — 30')	<20	10/16/95
SAI-9 (8 — 10')	<5,000	10/19/95
SAI-9 (16 — 18')	<5,000	10/19/95
SAI-10 (12 — 14')	12	10/16/95
SAI-10 (28 — 30')	35	10/16/95
SAI-11 (12 — 14')	3	10/16/95
SAI-11 (28 — 30')	12	10/16/95
SAI-12 (28 — 30')	<5,000	10/19/95
SAI-12 (12 — 14')	<5,000	10/19/95
SAI-13 (12 — 14')	23,000	10/19/95
SAI-13 (28 — 30')	<5	10/19/95
SAI-14 (4 — 6')	<5,000	10/19/95
SAI-14 (28 — 30')	<5,000	10/19/95
SAI-15 (12 — 14')	<5,000	10/19/95
SAI-15 (28 — 30')	<5,000	10/19/95



Table 5-20  
Field Screening Results  
for 1,2-Dichloroethane in Soil

Sample Number	Results (ppb)	Collection Date
SAI-16 (12 — 14')	<5,000	10/19/95
SAI-16 (28 — 30')	<5,000	10/19/95
SAI-17 (12 — 14')	<5,000	10/19/95
SAI-17 (28 — 30')	23,000	10/19/95
SAI-18 (12 — 14')	0	10/16/95
SAI-18 (28 — 30')	48	10/16/95
SAI-19 (12 — 14')	60	10/13/95
SAI-19 (28 — 30')	19,000	10/11/95
SAI-20 (12 — 14')	<5,000	10/16/95
SAI-20 (28 — 30')	490	10/16/95
SAI-21 (12 — 14')	<5,000	10/18/95
SAI-21 (26 — 28')	48,000	10/18/95
SAI-22 (18 — 20')	<5,000	10/19/95
SAI-22 (32 — 34')	<5,000	10/19/95
SAI-23 (10 — 12')	<5,000	10/19/95
SAI-24 (10 — 12')	<5,000	11/07/95
SAI-24 (28 — 30')	<5,000	11/07/95
SAI-25 (12 — 14')	<5,000	11/08/95
SAI-25 (28 — 30')	<5,000	11/08/95
SAI-26 (12 — 14')	<5,000	11/08/95
SAI-26 (28 — 30')	<5,000	11/08/95
SAI-27 (12 — 14')	<5,000	11/08/95
SAI-27 (28 — 30')	<5,000	11/08/95
SAI-28 (12 — 14')	<5,000	11/08/95
SAI-28 (30 — 32')	<5,000	11/08/95
SAI-28 (30 — 32')	<5,000	11/08/95

**Notes:**

- <20 ppb = Initially, soil samples were analyzed at a 1 times dilution with 20 ppb being the calculated quantitation limit of the field GC.
- <5,000 ppb = Later samples were analyzed only at a 1,000 times dilution for a calculated quantitation limit of 5,000 ppb or 5 ppm.



Table 5-21  
Source Area Investigation  
Contract Laboratory Split Soil Samples  
Volatile Organic Compounds (results in ppb)

Detected Compound	Sample ID									
	SAI-1 (2-4')	SAI-1 (32-34')	SAI-12 (0-2')	SAI-23 (13-16')	SAI-24 (10-12')	SAI-24 (28-30')	SAI-25 (12-14')	SAI-25 (28-30')	SAI-26 (12-14')	SAI-26 (28-30')
Acetone	U	U	50	5600	U	U	41	U	U	U
Benzene	U	U	U	220	U	U	18	U	U	U
Bromodichloromethane	U	U	U	17	U	U	U	U	U	U
Bromoform	U	U	U	100	U	U	U	U	U	U
2-Butanone	29	U	U	150	U	U	U	U	U	U
Chlorobenzene	U	U	U	37	U	U	U	U	U	U
Chloroform	U	U	U	160	U	U	U	U	U	U
Dibromochloromethane	U	U	U	74	U	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	3400	U	U	U	U	U	U
1,4-Dichlorobenzene	U	U	U	56	U	U	U	U	U	U
1,2-Dichloroethane	U	U	U	1100	U	U	U	U	U	U
Ethylbenzene	U	U	U	1800	U	U	U	U	U	U
2-Hexanone	U	U	U	14	U	U	U	U	U	U
Methylene Chloride	54	U	U	40	26	U	56	29	U	35
Styrene	U	U	U	180	U	U	U	U	U	U
Xylene (total)	U	U	U	4700	U	U	U	U	U	U
o-Xylene	U	U	U	5900	U	U	U	U	U	U

Note:  
U = Undetected



Table 5-22  
Source Area Investigation  
Contract Laboratory Split Soil Samples  
Semivolatile Organic Compounds (results in  $\mu\text{g/kg}$ )

Detected Compound	Sample ID							
	SAI-2 (28-30')	SAI-5 (2-4')	SAI-9 (12-14')	SAI-9 (26-28')	SAI-11 (2-4')	SAI-11 (12-14')	SAI-14 (6-8')	SAI-23 (14-16')
Benzoic Acid	U	U	U	U	U	U	U	500
4-Chloroaniline	U	U	U	U	U	U	U	1300
1,2-Dichlorobenzene	U	U	U	U	U	U	U	4500
3,4-Dichloroaniline	U	2800	U	U	530	U	U	51000
Dinoseb	U	61000	51000	890	50000	12000	990	91000
Propanil	U	U	U	U	U	U	U	19000

*Note:*

U = Undetected



Table 5-23  
 Source Area Investigation  
 Contract Laboratory Split Soil Samples  
 Chlorinated Pesticides (results in ppb)

Detected Compound	Sample ID					
	SAI-5 (2-4')	SAI-6 (20-22')	SAI-6 (28-30')	SAI-9 (12-14')	SAI-9 (26-28')	SAI-23 (14-16')
gamma-BHC (Lindane)	4.7	U	U	U	U	30
Endrin	U	U	U	U	U	10
Endosulfan II	U	U	U	U	U	16
Methoxychlor	U	U	U	U	U	470
Endrin Aldehyde	U	U	U	U	U	15
Endrin Ketone	10	U	U	U	U	34

**Note:**

U = Undetected



Table 5-24  
Cedar Chemical  
Air Monitoring Results

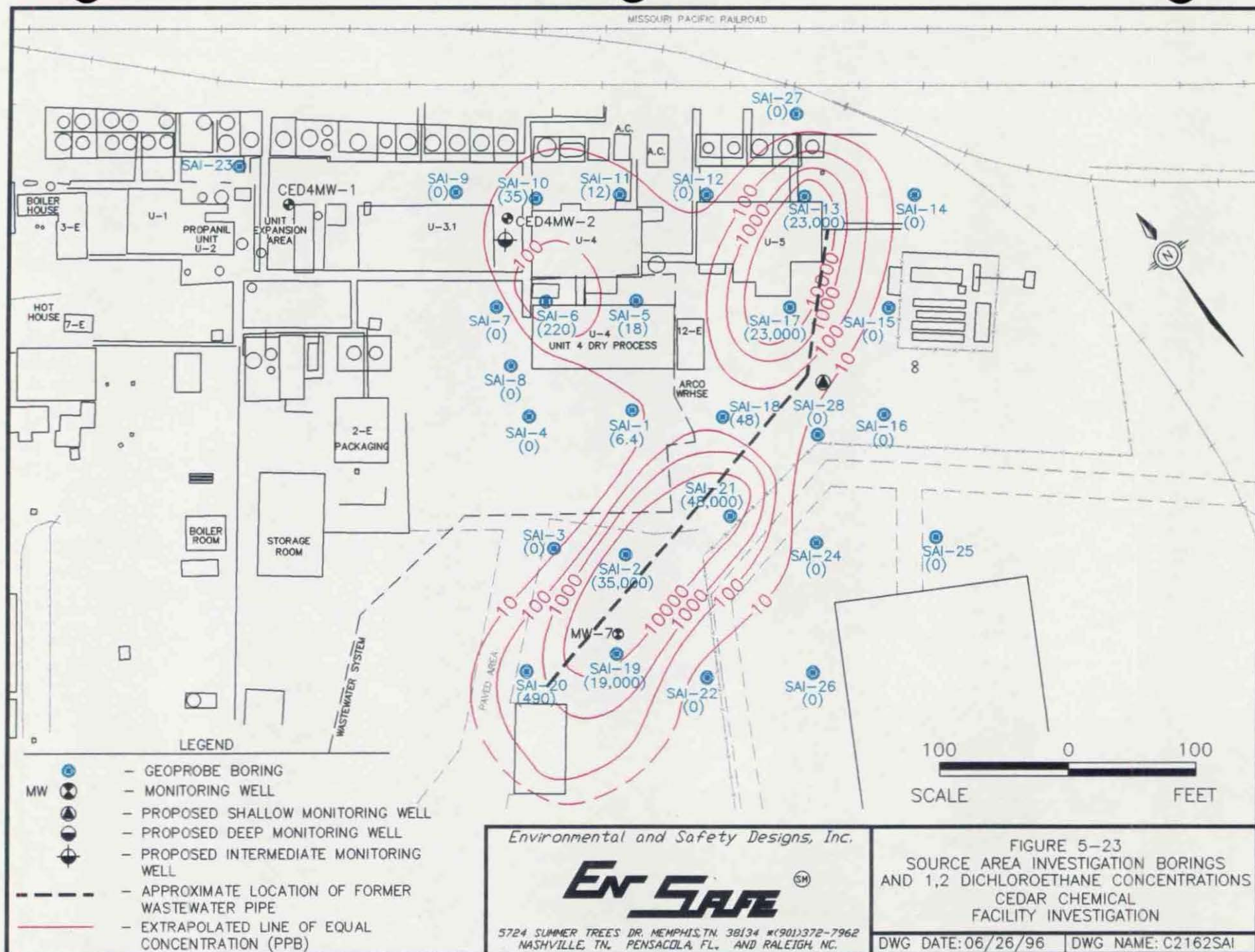
Station Number	Date	Time	Wind Direction	Wind Speed (calm, light, strong)	Organic Vapor Concentration (ppm)	Comments
Station 1	12/04/95	1405	NE	Light	0.7	Calibration may be off on 12/4
Site 4	12/05/95	940	W	Light	0.5	
	12/05/95	1616	N	Light	2.1	
	12/06/95	0808	NE	Light	0	
	12/06/95	1504	NNE	Light to strong	0	
	12/07/95	0743	N	light	0	
	12/07/95	1532	N	strong	0	
	12/08/95	0752	E	light	0	
	12/11/95	0813	E	calm	0	
Station 2	12/04/95	1407	NE	Light	0.6	Calibration may be off on 12/4
Site 6	12/05/95	0936	W	Light	0.5	
	12/05/95	1613	N	Light	0	
	12/06/95	0804	NE	Light	0	
	12/06/95	1505	NNE	Light to strong	0	
	12/07/95	0740	N	light	0	
	12/07/95	1536	N	strong	0	
	12/08/95	0759	E	light	0	
	12/11/95	0810	E	calm	0	
Station 3	12/04/95	1745	NE	Light	0.8	Calibration may be off on 12/4
Site 1	12/05/95	0955	W	Light	0	
	12/05/95	1603	N	Light	0	
	12/06/95	0820	NE	Light	0	
	12/06/95	1455	NNE	Light to strong	0	
	12/07/95	0758	N	light	0	
	12/07/95	1548	N	strong	0	
	12/08/95	0811	E	light	0	
	12/11/95	0836	E	calm	0	



Table 5-24  
Cedar Chemical  
Air Monitoring Results

Station Number	Date	Time	Wind Direction	Wind Speed (calm, light, strong)	Organic Vapor Concentration (ppm)	Comments
Station 4	12/04/95	1747	NE	Light	1	Calibration may be off on 12/4
Site 2	12/05/95	0946	W	Light	0	
	12/05/95	1620	N	Light	0	
	12/06/95	0813	NE	Light	0	
	12/06/95	1500	NNE	Light to strong	0	
	12/07/95	0752	N	light	0	
	12/07/95	1524	N	strong	0	
	12/08/95	0745	E	light	0	
	12/11/95	0818	E	calm	0	
Station 5	12/05/95	0949	W	Light	0	
Site 9	12/05/95	1622	N	Light	0	
	12/06/95	0815	NE	Light	0	
	12/06/95	1508	NNE	Light to strong	0	
	12/07/95	0748	N	light	0	
	12/07/95	1529	N	strong	0.5	Probably from Site 4
	12/08/95	0804	E	light	0	
	12/11/95	0825	E	calm	0	











## **6.0 GROUNDWATER ASSESSMENT**

Groundwater has been assessed during each phase of the FI and contamination is being monitored through a quarterly sampling program. Because of temporal and spatial variability within the aquifer and the contaminant plumes, each event is discussed separately in this section. Overall conclusions regarding groundwater will be discussed in Section 7.

### **6.1 Site-Specific Hydrogeologic Setting**

Previous investigations by GG&H (1988) and Phase I subsurface investigations (1993) identified two aquifer regimes onsite: the primary alluvial aquifer and a minor discontinuous perched zone in the surficial sediments. The discontinuous perched zone is encountered at Sites 1, 2, and 3 in disturbed soil or fill material atop a surficial clay lens. The surficial clay is encountered between 10 and 20 feet bgs. The alluvial aquifer extends from 30 to 40 feet bgs to approximately 150 feet bgs, where it contacts stiff clay and lignite characteristic of the Jackson-Claiborne Group.

#### **6.1.1 Perched Zone**

The discontinuous perched zone occurs in a silty, unconfined unit ranging from 2 to 10 feet thick. Static water levels depend on the volume of recharge from seasonal rainfall. The zone is associated with disturbed soil, such as at the former waste ponds at Site 2 and fill material at Site 3. A perched zone is also present beneath the storm water treatment ponds at Site 1. Perched groundwater was not encountered on top of the clay in the northern portion of the site. Six wells are screened in the perched zones at Sites 1 and 2: 1MW-1, 1MW-2, 1MW-3, 1MW-4, 1MW-5, 2MW-1, and 2MW-2. Three additional monitoring wells from previous hydrogeological investigations (EMW-1, EMW-4, and EMW-6B) are screened in the perched zone. Slug tests were performed on two perched zone wells during Phase II activities, and results from these slug tests are discussed in Section 6.3.



### 6.1.2 Alluvial Aquifer

The alluvial aquifer comprises silty sand, sand, and gravel, typically grading from fine to coarse with depth. The aquifer is present under confined or unconfined conditions across most of northeastern Arkansas. Onsite, the aquifer appears to be confined between the surficial clay material and the basal Jackson Clay. It is a major source of groundwater for agriculture in eastern Arkansas, with wells screened in this aquifer typically producing more than 500 gpm (Todd, 1983). Literature data indicate that transmissivities in this aquifer range from 34,000 ft<sup>2</sup>/day to 35,000 ft<sup>2</sup>/day (USGS, 1982). GG&H's hydrogeological investigations at the site suggested lower transmissivities, 16 ft<sup>2</sup>/day to 7,800 ft<sup>2</sup>/day (Grubbs, 1988).

Four wells installed in the alluvial aquifer during previous investigations are present onsite; EMW-2, EMW-3, EMW-6, and EMW-6A. Six wells (1MW-6, 2MW-3, 2MW-4, 2MW-5, 4MW-1, and 4MW-2) were installed into this zone during Phase I investigations. Six additional wells were installed into the alluvial aquifer during Phase II activities: 1MW-7, 2MW-6, 2MW-7, 4MW-3, 4MW-4, and 9MW-1. Slug tests performed on this zone during Phase II activities are discussed in Section 6.3. Four alluvial wells (OFFMW-1, OFFMW-2, OFFMW-3, and OFFMW-4) were installed offsite during Phase III investigations.

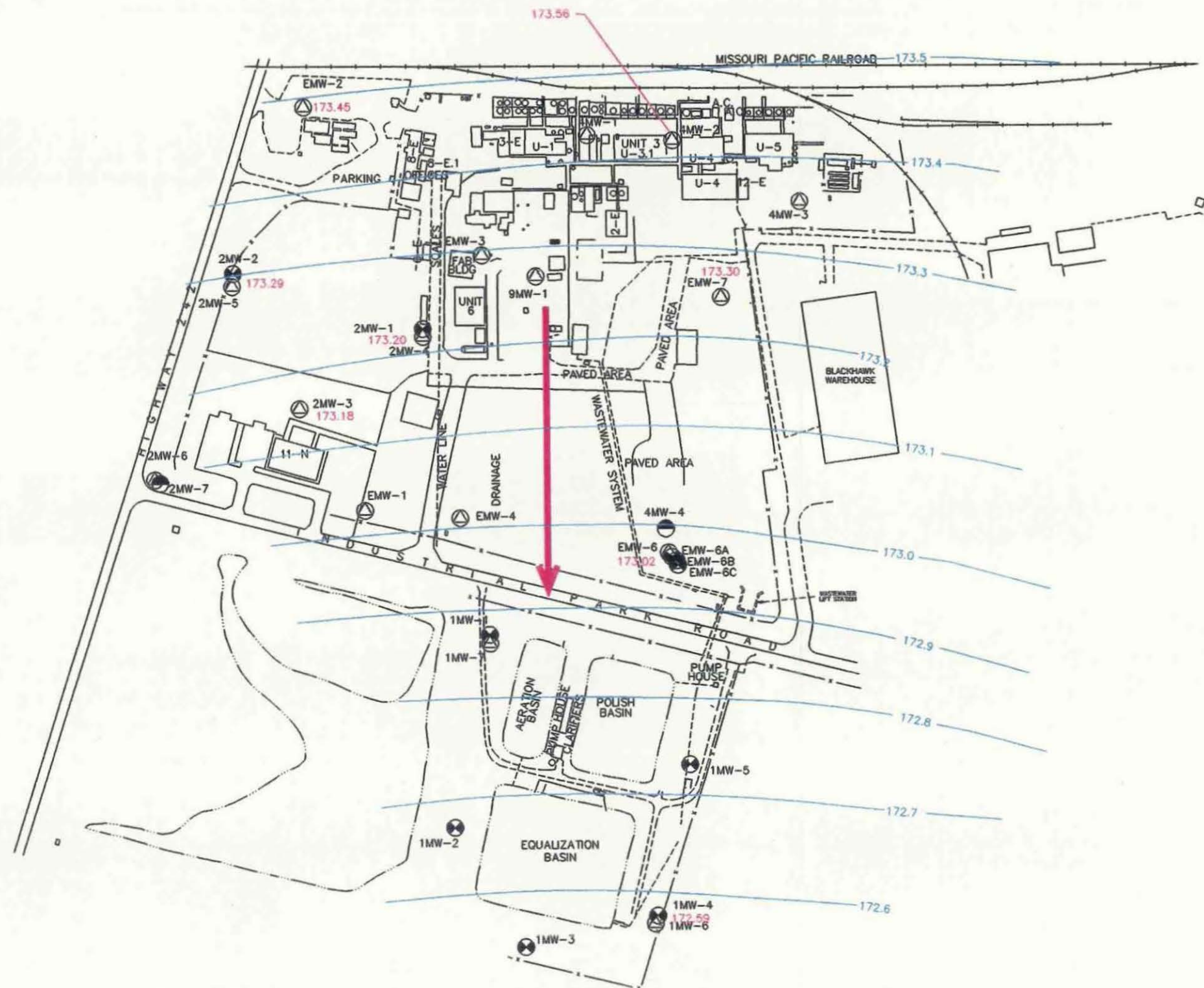
Grain size analyses were performed on Shelby tube samples obtained from the alluvial aquifer during the FI. Grain size curves are presented in Appendix B. These data agree with regional information, which indicates the aquifer coarsens with depth to a fine- to medium-grained sand and gravel.

### 6.1.3 Potentiometric Surface Data

#### Alluvial Aquifer

To facilitate the discussion of groundwater contamination relative to the site and potential source areas, potentiometric surface maps for the alluvial aquifer are presented in Figures 6-1 through 6-3. These figures show the overall hydraulic gradient at the site and general flow





- LEGEND**
- WATER OR DRAINAGE
  - ROAD
  - +++ RAILROAD
  - BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊙ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊙ DEEP MONITORING WELL
  - POTENTIOMETRIC SURFACE CONTOURS (CONTOUR INTERVAL 0.1 FEET)
  - GROUNDWATER FLOW DIRECTION

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

**EN SAFE**

5724 SUMMER TREES DR. MEMPHIS, TN 38134 (901)372-7962  
NASHVILLE, TN, PENSACOLA, FL, AND RALEIGH, NC

FIGURE 6-1  
PHASE I OCTOBER 1993  
ALLUVIAL POTENTIOMETRIC  
SURFACE MAP  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162165











directions of groundwater. Figure 6-1 shows the potentiometric surface for Phase I data. Figure 6-2 shows the potentiometric surface measured during Phase II, November 1994. Figure 6-3 shows the potentiometric surface measured during Phase II, January 1995. Figure 6-4 presents the potentiometric surface measured during the first-quarter groundwater monitoring event conducted in April 1996. Table 6-1 presents water level elevations and identifies the wells used to develop these figures.

The four figures display very similar contour configurations. The general flow direction is predominantly south to south-southwest. The average hydraulic gradient for Phase I data is 0.0006 feet/foot (ft/ft). The average gradients measured using Phase II and April 1996 data are also 0.0006 ft/ft. Data obtained during the Phase II investigation reflect a 4-foot rise in head between November 1994 and January 1995; groundwater elevations from the April 1996 event are 1 to 2 feet lower than those measured during January 1995. These data indicate that the unit is dynamic and responsive to seasonal fluctuations in rainfall.

These figures differ significantly from those developed for the *Technical Memorandum* (EnSafe, 1993) and *Phase II Work Plan* (EnSafe, 1994), which portrayed a groundwater ridge running northeast-southwest across the site. Groundwater flow appeared bidirectional, with major gradients to the east and west. Further evaluation of data, including monitoring wells installed by GG&H and Phase II lithologic borings, suggest that EMW-1 and EMW-4 are screened in the surficial clay. As a result, these wells are not connected with the alluvial aquifer. When these anomalous groundwater elevations are removed from the potentiometric surface, a different flow pattern is developed; the gradient resembles those shown in Figures 6-2 through 6-4. This surface is more representative of actual aquifer conditions and better correlates with actual contaminant migration patterns.

An overall potentiometric surface for the perched aquifer was not developed as it is discontinuous and appears to fluctuate seasonally. However, groundwater elevations measured



Table 6-1  
Potentiometric Surface Elevations (ft msl)

Well	Screened Zone	Installation Phase	Phase I	Phase II November 1994 <sup>d</sup>	Phase II January 1995	April 1, 1996 Event
1MW-1	Perched	Phase I	179.99	—	186.31	186.98
1MW-2	Perched	Phase I	177.30	—	185.84	186.28
1MW-3	Perched	Phase I	175.16	—	184.03	180.55
1MW-4	Perched	Phase I	176.6	—	183.70	183.67
1MW-5	Perched	Phase I	181.16	—	186.96	186.92
1MW-6	Alluvial	Phase I	172.59	174.85	176.73	175.12
1MW-7	Alluvial	Phase II	—	—	177.06	175.41
2MW-1	Perched	Phase I	176.17	—	177.31	—
2MW-2	Perched	Phase I	171.89	—	185.68	—
2MW-3	Alluvial	Phase I	173.18	174.62	177.34	175.72
2MW-4	Alluvial	Phase I	173.20	174.54	177.24	175.66
2MW-5	Alluvial	Phase I	173.29	174.79	177.55	175.82
2MW-6	Alluvial	Phase II	—	—	177.37	175.74
2MW-7	Alluvial <sup>a</sup>	Phase II	—	—	177.36	175.67
4MW-1	Alluvial	Phase I	178.97 <sup>e</sup>	—	178.85 <sup>e</sup>	176.28
4MW-2	Alluvial	Phase I	173.56	—	177.52	175.87
4MW-3	Alluvial	Phase II	—	—	177.31	175.7
4MW-4	Alluvial <sup>a</sup>	Phase II	—	—	177.10	175.39
9MW-1	Alluvial	Phase II	—	—	— <sup>e</sup>	—
OFFMW-1	Alluvial	Phase III	—	—	—	NA



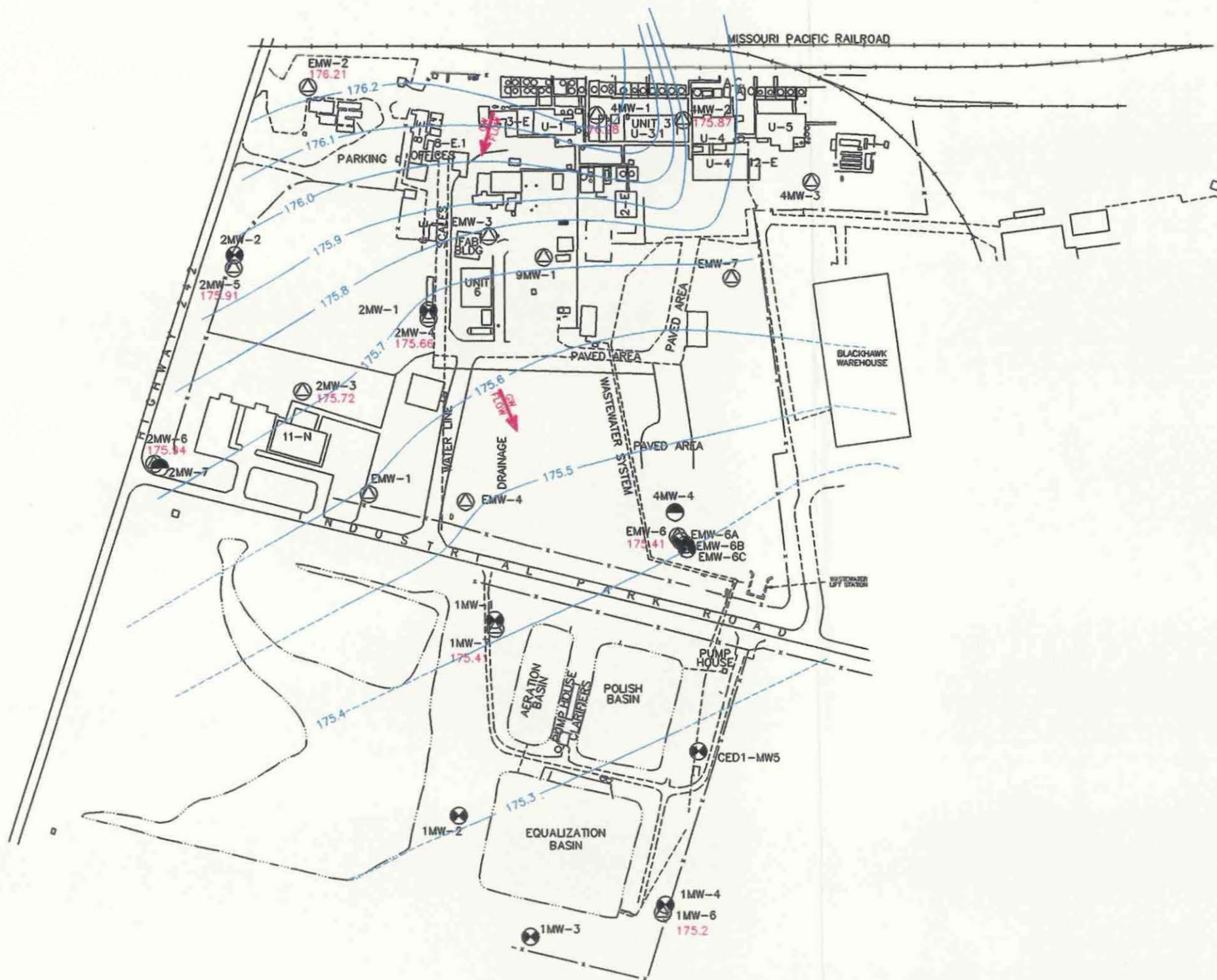
Table 6-1  
Potentiometric Surface Elevations (ft msl)

Well	Screened Zone	Installation Phase	Phase I	Phase II November 1994 <sup>d</sup>	Phase II January 1995	April 1, 1996 Event
OFFMW-2	Alluvial	Phase III	—	—	—	NA
OFFMW-3	Alluvial	Phase III	—	—	—	NA
OFFMW-4	Alluvial	Phase III	—	—	—	NA
EMW-1	Perched	GG&H	179.04	181.33	185.41	185.58
EMW-2	Alluvial	GG&H	173.45	174.93	177.67	176.21
EMW-3	Alluvial	GG&H	173.10 <sup>c</sup>	174.47	177.21 <sup>c</sup>	175.62
EMW-4	Perched	GG&H	182.26	181.33	184.33	162.14
EMW-6	Alluvial <sup>b</sup>	GG&H	173.02	174.26	177.06	175.41
EMW-6A	Alluvial	GG&H	172.92 <sup>c</sup>	174.26	177.06	175.43
EMW-6B	Perched	GG&H	183.91	174.53	185.55	166.92
EMW-7	Alluvial	GG&H	173.30	174.53	177.29	175.67

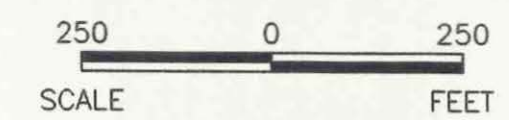
**Notes:**

- a = 2MW-7 and 4MW-4 are screened at depth (130 to 150 feet bgs) in the alluvial aquifer. All other alluvial wells, except as noted, are screened between 30 and 50 feet bgs.
- b = CEDE-MW6 is screened approximately 80 feet bgs.
- c = Water levels in these wells appeared anomalous with other data, and were not used to develop the potentiometric surface map. These anomalies may be attributable to measurement error or variations in screened depth.
- d = The November 1994 measuring event was limited to alluvial wells only.
- e = Groundwater elevations were not calculated for 9MW-1. All measurements were made from top of casing, but only ground surface elevations were measured at this well.
- = Indicates that no data are available.
- NA = Indicates that data are not available because wells were not surveyed.





- LEGEND**
- WATER OR DRAINAGE
  - ROAD
  - |||| - RAILROAD
  - BUILDING
  - FENCE
  - SUBSURFACE PIPING (APPROX.)
  - ⊙ - MONITORING WELL
  - ⊙ - SHALLOW MONITORING WELL
  - ⊙ - DEEP MONITORING WELL
  - POTENTIOMETRIC SURFACE
  - - GROUNDWATER FLOW DIRECTION



MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.



5724 SUMMER TREES DR. MEMPHIS, TN 38134 (901) 372-7962  
NASHVILLE, TN, PENSACOLA, FL, AND RALEIGH, NC

FIGURE 6-4  
ALLUVIUM POTENTIOMETRIC SURFACE MAP  
APRIL 1, 1996  
CEDAR CHEMICAL  
INTERIM RESPONSE WORK PLAN

DWG DATE: 06/27/96 DWG NAME: C2162PTS



during the January 1995 Phase II event were used to evaluate the potentiometric surface at Site 1; this surface is presented in Figure 6-5. Perched groundwater at this site flows to the southwest, with a gradient of 0.01 ft/ft in the southern portion of the site. As is evident in Table 6-1, groundwater elevations have varied significantly (by more than 5 feet) between monitoring events, and they do not trend consistently up or down, suggesting that water levels are highly dependent on seasonal rainfall.

## **6.2 Analytical Characterization**

Analytical characterization was performed in two phases. The first (conducted during the fall of 1993) identified the primary contaminants of concern and roughly identified the contaminated areas. Phase II (conducted during the winter of 1994/1995) further delineated the groundwater contaminant plumes both vertically and horizontally using both monitoring wells and Geoprobe techniques. Phase III investigations continued offsite groundwater characterization in a similar fashion during the fall of 1995. Analytical data collected during the FI may be found in Appendix F.

### **6.2.1 Phase I Data**

Groundwater analytical data collected during Phase I activities indicate that 1,2-dichloroethane and dinoseb are the primary contaminants of concern in the alluvial and perched aquifers. Several other compounds, including toluene, benzene, 1,2-dichlorobenzene, chloroform, chlorobenzene, methylene chloride, and isophorone were identified at concentrations greater than maximum contaminant levels (MCLs) as well. However, these contaminants were not widespread and usually correspond with 1,2-dichloroethane contamination. Groundwater data for Phase I may be found in Table 6-2.



Table 6-2  
Phase I Facility Investigation  
Groundwater Data

Compound	1MW-1	1MW-2	1MW-3	1MW-4	1MW-5	1MW-6	2MW-1	2MW-2	2MW-3	2MW-4	2MW-5
<b>Volatiles (ppb)</b>											
Ethylbenzene	U	U	U	U	U	U	U	U	U	U	U
1,2-Dichloroethane	19	U	2,700	1,800	U	640	29,000	U	120	500	U
4-Methyl-2-Pentanone	U	U	U	U	U	U	2,200	U	520	U	U
Toluene	U	U	U	U	U	U	940	U	160	U	U
Chlorobenzene	U	U	U	U	U	U	U	U	U	470	U
Tetrachloroethene	U	U	U	U	U	U	U	U	U	U	U
Total Xylenes	U	U	U	U	U	U	1,100	U	4	U	U
2-Hexanone	U	U	U	U	U	U	U	U	U	U	U
Acetone	U	U	U	U	U	U	4,800	U	430	U	U
Chloroform	2	U	U	U	2	U	700	U	340	U	3
Benzene	U	U	U	U	U	U	U	U	U	7	U
Methylene Chloride	U	U	U	U	U	U	600,000	U	460	720	U
2-Butanone	U	U	U	U	U	U	U	U	U	U	U
Trichloroethene	U	U	U	28	U	U	U	U	U	U	U
<b>Semivolatiles (ppb)</b>											
4-Nitrophenol	U	U	U	U	U	U	NA	U	250	U	U
2,4-Dimethylphenol	U	U	U	U	U	U	NA	U	U	U	U
4-Methylphenol	U	U	U	U	U	U	NA	U	8	U	U
1,4-Dichlorobenzene	U	U	4	U	U	U	NA	U	U	U	U
Phenol	U	U	U	U	U	U	NA	U	950	U	U



Table 6-2  
Phase I Facility Investigation  
Groundwater Data

Compound	1MW-1	1MW-2	1MW-3	1MW-4	1MW-5	1MW-6	2MW-1	2MW-2	2MW-3	2MW-4	2MW-5
Semivolatiles (ppb)											
Bis-(2-chloroethyl)ether	U	U	U	U	U	U	NA	U	U	13	U
1,2,4-Trichlorobenzene	U	U	U	U	U	U	NA	U	U	U	U
2,4-Dinitrophenol	U	U	U	U	U	U	NA	U	U	U	U
Dimethylphthalate	U	U	U	U	U	U	NA	U	U	U	U
2,4-Dinitrophenol	U	U	U	U	U	U	NA	U	U	U	U
1,3-Dichlorobenzene	U	U	4	U	U	U	NA	U	U	U	U
2,6-Dinitrotoluene	U	U	U	U	320	U	NA	U	U	U	U
Benzoic Acid	U	U	U	U	U	11	NA	U	U	U	U
Propanil	U	U	U	U	U	U	NA	U	6	U	1
Isophorone	U	U	U	U	U	U	NA	U	U	U	U
Diethylphthalate	U	U	U	U	U	U	NA	U	U	U	1
Di-n-butyl phthalate	U	U	2	U	U	U	NA	U	U	U	U
Dinoseb	U	U	U	U	U	U	NA	U	U	U	39
Naphthalene	U	U	U	U	U	U	NA	U	1	U	U
2-Methylnaphthalene	U	U	U	U	U	U	NA	U	U	U	U
2-Methylphenol	U	U	U	U	U	U	NA	U	3	U	U
1,2-Dichlorobenzene	U	U	31	U	U	U	NA	58	11	28	7
2-Chlorophenol	U	U	U	U	U	U	NA	U	U	U	U
3,4-Dichloroaniline	U	U	55	12	13	U	NA	220	U	U	U



Table 6-2  
Phase I Facility Investigation  
Groundwater Data

Compound	1MW-1	1MW-2	1MW-3	1MW-4	1MW-5	1MW-6	2MW-1	2MW-2	2MW-3	2MW-4	2MW-5
Pesticides (ppb)											
alpha-BHC	U	U	U	U	U	U	U	U	U	U	U
beta-BHC	U	U	U	U	U	U	U	U	U	U	U
4,4'-DDT	U	U	U	U	U	U	U	U	U	U	U
Dieldrin	U	U	U	U	U	U	U	U	U	U	U
Methoxychlor	U	U	U	U	U	U	3	U	U	U	U
Metals (ppb)											
Lead	41	25	38	11	16	16	NA	60	31	39	21
Arsenic	39	22	45	14	20	24	NA	60	59	32	U
Barium	923	513	639	441	324	553	NA	576	1,670	1,100	217
Cadmium	U	U	U	U	U	U	NA	4	U	3	U
Chromium	81	47	81	21	48	13	NA	102	29	62	19
Mercury	U	U	U	U	U	U	NA	0	U	U	U
Selenium	U	U	U	U	U	U	NA	U	U	6	U
Calcium	304,000	74,100	294,000	285,000	360,000	334,000	NA	187,000	198,000	452,000	135,000
Iron	109,000	53,600	107,000	22,500	42,300	18,300	NA	127,000	42,400	51,000	21,100
Magnesium	174,000	65,100	261,000	240,000	197,000	72,900	NA	82,500	99,500	205,000	44,600
Sodium	921,000	67,700	525,000	379,000	906,000	72,300	NA	266,000	93,300	82,500	36,600



Table 6-2  
Phase I Facility Investigation  
Groundwater Data

Compound	4MW-1	4MW-2	EMW-1	EMW-2	EMW-3	EMW-4	EMW-6	EMW-6A	EMW-6B	EMW-7
Volatiles (ppb)										
Ethylbenzene	U	U	U	U	54	U	U	U	U	U
1,2-Dichloroethane	5,800	210	36	U	6,100	1,200	190	18	1,900	64,000
4-Methyl-2-Pentanone	U	U	U	U	11	U	U	U	U	U
Toluene	110,000	80	U	U	32	U	U	U	U	U
Chlorobenzene	U	31	U	U	26	16	U	U	30	U
Tetrachloroethene	U	U	U	U	U	U	U	U	U	U
Total Xylenes	1,400	38	U	U	88	U	U	U	U	U
2-Hexanone	U	U	U	U	U	U	U	U	U	U
Acetone	U	U	U	U	U	U	U	U	U	U
Chloroform	U	1,400	1	U	55	U	U	U	U	U
Benzene	U	46	U	U	U	U	U	U	17	U
Methylene Chloride	U	U	U	U	390	U	U	U	U	U
2-Butanone	U	U	U	U	U	U	U	U	U	U
Trichloroethene	U	U	U	U	U	U	U	U	U	U
Semivolatiles (ppb)										
4-Nitrophenol	U	U	U	U	U	U	U	U	U	U
2,4-Dimethylphenol	U	U	U	U	2	U	U	U	U	U
4-Methylphenol	23	U	U	U	U	U	U	U	U	U
1,4-Dichlorobenzene	U	U	2	U	U	U	U	U	U	U
4-Chloroaniline	23	5	5	U	40	130	U	U	5,900	65



Table 6-2  
Phase I Facility Investigation  
Groundwater Data

Compound	4MW-1	4MW-2	EMW-1	EMW-2	EMW-3	EMW-4	EMW-6	EMW-6A	EMW-6B	EMW-7
Semivolatiles (ppb)										
Phenol	U	U	U	U	U	1	U	U	U	U
Bis-(2-chloroethyl)ether	U	U	U	U	U	5	U	U	U	U
1,2,4-Trichlorobenzene	U	U	U	U	2	U	U	U	U	U
2,4-Dinitrophenol	U	U	U	U	2	U	U	U	U	U
Dimethylphthalate	U	U	U	10	U	U	U	U	U	U
2,4-Dinitrophenol	U	110	109	U	U	U	U	U	U	U
1,3-Dichlorobenzene	U	U	U	U	U	U	U	U	U	U
2,6-Dinitrotoluene	U	U	U	U	U	U	U	U	U	13
Benzoic Acid	57	U	U	U	U	U	U	U	U	U
Propanil	45	U	U	U	U	U	U	U	18	U
Isophorone	17	2	2	U	2	U	U	U	U	U
Diethylphthalate	1	U	U	U	2	U	U	U	U	U
Di-n-butyl phthalate	U	U	U	U	U	U	U	U	U	U
Dinoseb	U	41,000	47,000	42	140	U	U	U	U	U
Naphthalene	2	U	U	U	4	U	U	U	15	U
2-Methylnaphthalene	U	U	U	U	1	U	U	U	6	U
2-Methylphenol	15	U	U	2	U	U	U	U	U	U
1,2-Dichlorobenzene	960	33	35	U	310	7	U	U	130	U
2-Chlorophenol	U	U	U	U	U	U	U	U	U	1
3,4-Dichloroaniline	66	22	26	U	670	63	U	U	58,000	U



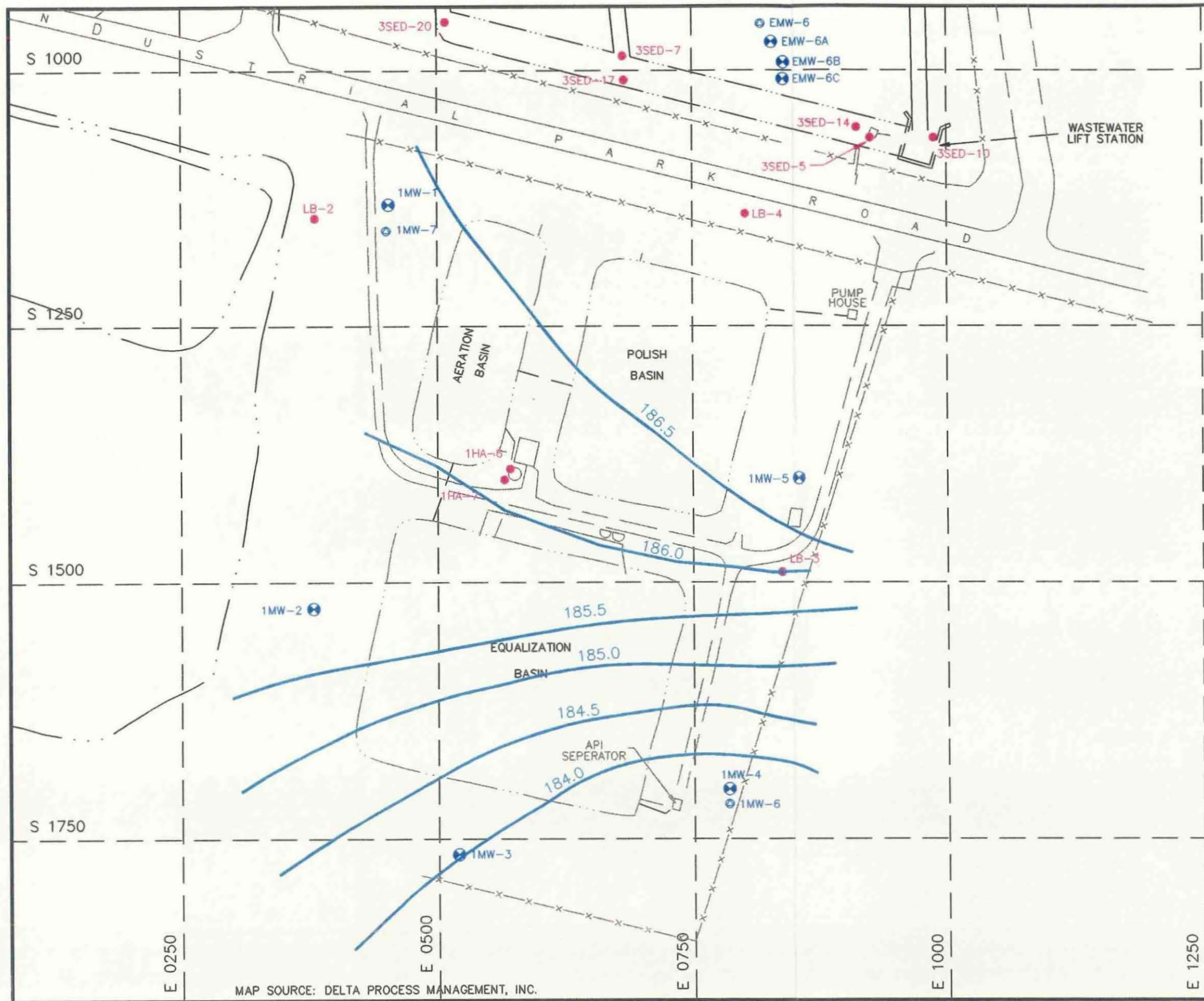
Table 6-2  
Phase I Facility Investigation  
Groundwater Data

Compound	4MW-1	4MW-2	EMW-1	EMW-2	EMW-3	EMW-4	EMW-6	EMW-6A	EMW-6B	EMW-7
Pesticides (ppb)										
alpha-BHC	U	U	0	U	0	U	U	U	U	U
beta-BHC	U	U	U	U	U	U	U	U	U	U
4,4'-DDT	U	U	0	U	U	1	U	U	U	U
Dieldrin	U	U	U	U	0	U	U	U	U	U
Methoxychlor	U	U	U	U	U	U	U	U	U	U
Metals (ppb)										
Lead	33	134	31	89	38	174	39	21	33	134
Arsenic	22	25	29	27	40	44	32	U	22	25
Barium	1,450	1,530	799	1,120	319	2,400	1,100	217	1,450	1,530
Cadmium	U	2	4	9	180	4	3	U	U	2
Chromium	41	120	63	104	800	226	62	19	41	120
Mercury	U	U	U	U	U	U	U	U	U	U
Selenium	U	U	U	U	U	U	6	U	U	U
Calcium	186,000	382,000	232,000	109,000	522,000	919,000	128,000	292,000	301,000	211,000
Iron	32,000	122,000	64,200	12,100	82,900	347,000	14,900	106,000	50,100	38,200
Magnesium	53,000	201,000	133,000	58,700	140,000	472,000	48,400	121,000	151,000	87,600
Sodium	87,200	27,000	98,300	33,400	171,000	137,000	40,800	17,400	226,000	15,100

Notes:

U = Not quantified above PQLs  
NA = Not analyzed





MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

#### LEGEND

- WATER OR DRAINAGE
- ROAD
- TRAIL
- SIDEWALK
- RAILROAD
- BUILDING
- FENCE
- SUBSURFACE PIPING (APPROX.)
- MONITORING WELL
- SHALLOW MONITORING WELL
- DEEP MONITORING WELL
- SOIL BORING
- POTENTIOMETRIC SURFACE CONTOURS (CONTOUR INTERVAL 0.5 FEET)

100 0 100  
SCALE FEET

Environmental and Safety Designs, Inc.

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FIGURE 6-5  
SITE 1 POTENTIOMETRIC SURFACE  
OF PERCHED GROUNDWATER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162S1P



### **1,2-Dichloroethane**

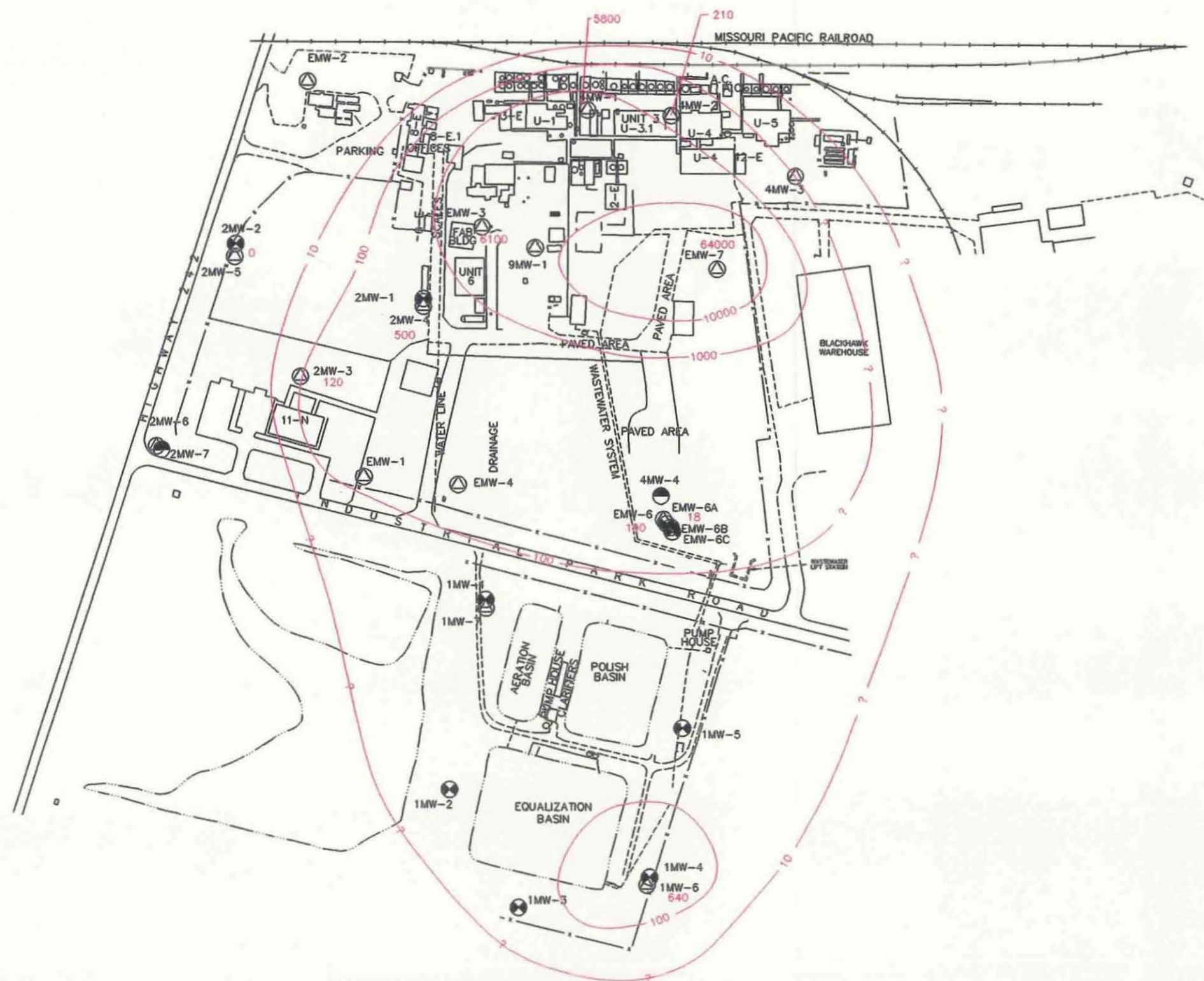
The compound 1,2-dichloroethane was identified in groundwater in nine wells above PQLs, as shown in Figure 6-6. Briefly, PQLs are the minimum practical detection limits for compounds analyzed using SW-846 methods. Typically, compounds below PQLs are considered below detectable limits. Figure 6-6 also shows isocons — equivalent concentration contours — on a log-scale.

Contaminant concentrations are highest in the northern portion of the site; during Phase I, the highest concentrations were detected in EMW-7 and EMW-3. However, contaminant concentrations for 1,2-dichloroethane also increase south of the main facility, beneath Site 1, suggesting that the wastewater treatment ponds may be a secondary source of contamination. Contaminant concentrations at Site 1 are several orders of magnitude less than in the northern portion of the site.

As shown in Figure 6-6, Phase I data suggested that the large 1,2-dichloroethane plume possibly extended beyond the property boundaries to the northeast, east, southeast, south, southwest, and west of the Cedar Chemical property. Data were insufficient to determine the vertical extent of contamination and the source area for the plume; therefore, additional delineation was proposed for the Phase II investigation.

Figure 6-7 shows 1,2-dichloroethane concentrations in the perched aquifer. High concentrations of 1,2-dichloroethane near Site 1 suggest that the ponds may have contributed dissolved-phase solvent to the perched and alluvial aquifers. Additional contamination is present in the perched zone immediately north of Industrial Park Road. The source area for 1,2-dichloroethane in this area is not clear, as none was identified in soil during the Site 3 investigation.





- LEGEND**
- WATER OR DRAINAGE
  - ROAD
  - +++ RAILROAD
  - BUILDING
  - FENCE
  - SUBSURFACE PIPING (APPROX.)
  - MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊗ DEEP MONITORING WELL
  - 10 — CONTAMINANT ISOCOON (PPB)
  - ? — ISOCOON INFERRED

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

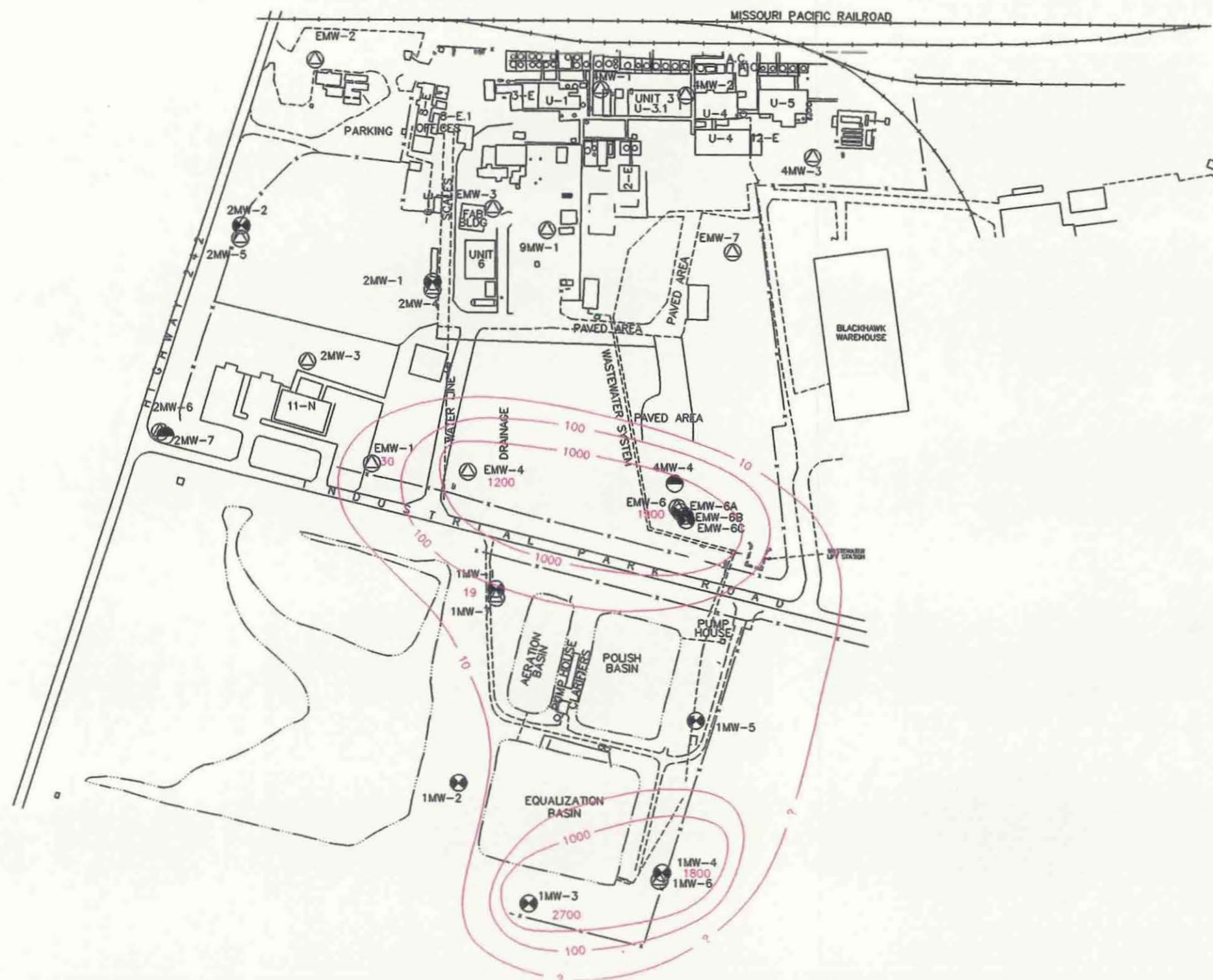
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FIGURE 6-6  
PHASE I 1,2-DICHLOROETHANE  
CONCENTRATIONS IN THE  
ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162168





- LEGEND**
- - - WATER OR DRAINAGE
  - == ROAD
  - +++ RAILROAD
  - ▭ BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊗ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊖ DEEP MONITORING WELL
  - 10 - - - CONTAMINANT ISOCON (PPB)
  - ? - - - ISOCON INFERRED

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

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FIGURE 6-7  
PHASE I 1,2-DICHLOROETHANE  
CONCENTRATIONS IN THE  
PERCHED AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162169



### **Dinoseb**

Figure 6-8 shows contaminant concentrations and isocons for dinoseb contamination in the alluvial aquifer. Dinoseb was quantified in three wells in the alluvial aquifer. The highest concentration, 41,000 ppb, was identified in 4MW-2; the lowest concentration, 39 ppb, was identified in 2MW-5. These wells trend east-west across the site. Although Site 9 is characterized with the highest dinoseb concentrations in soil, the groundwater plume does not correlate well with this potential source area. In contrast, the area of highest groundwater contamination is northeast of Site 9.

In general, Phase I alluvial groundwater data suggested that a dinoseb source area may exist near 4MW-2 and that contamination associated with the Site 9 ponds may contribute to alluvial groundwater contamination near EMW-3. Phase II activities were structured to delineate the vertical extent of contamination near both 4MW-2 and EMW-3, and to refine the lateral extent of contamination north of 4MW-2 and south of Site 9.

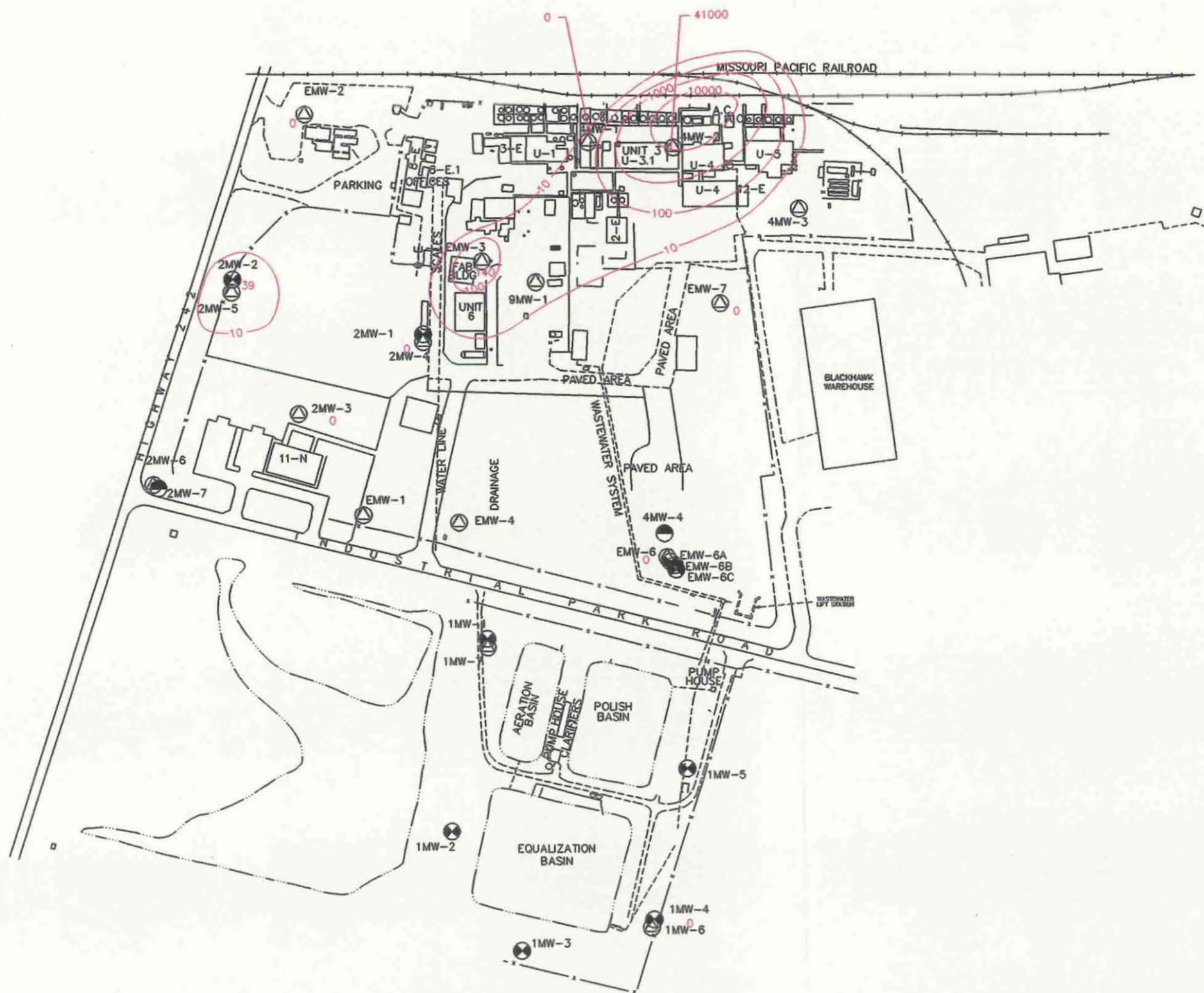
No dinoseb was identified in perched zone wells during the Phase I investigation.

### **Miscellaneous Organic Compounds**

Figure 6-9 identifies compounds quantified above the appropriate MCLs at different locations in the alluvial aquifer. There is no noticeable spatial relationship between these exceedances and no continuity of transport. However, each exceedance occurs where there is a relatively high concentration of 1,2-dichloroethane. The primary location of volatile contaminants is 4MW-1, which contains toluene, methylene chloride, and 1,2-dichlorobenzene.

Several compounds were quantified above the appropriate MCLs at two locations in the perched aquifer. Most notably, 2MW-1 contains high concentrations of methylene chloride and chlorobenzene. Methylene chloride was identified as a primary contaminant of concern in Site 2 soil. At Site 1, only trichloroethene was quantified above the MCL at 1MW-4.





- LEGEND**
- - - WATER OR DRAINAGE
  - == ROAD
  - ++++ RAILROAD
  - BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊙ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊙ DEEP MONITORING WELL
  - 10 - - - CONTAMINANT ISOCOCON (PPB)
  - ? - - - ISOCOCON INFERRED



MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

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FIGURE 6-8  
PHASE I DINOSEB  
CONCENTRATIONS IN THE  
ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162170



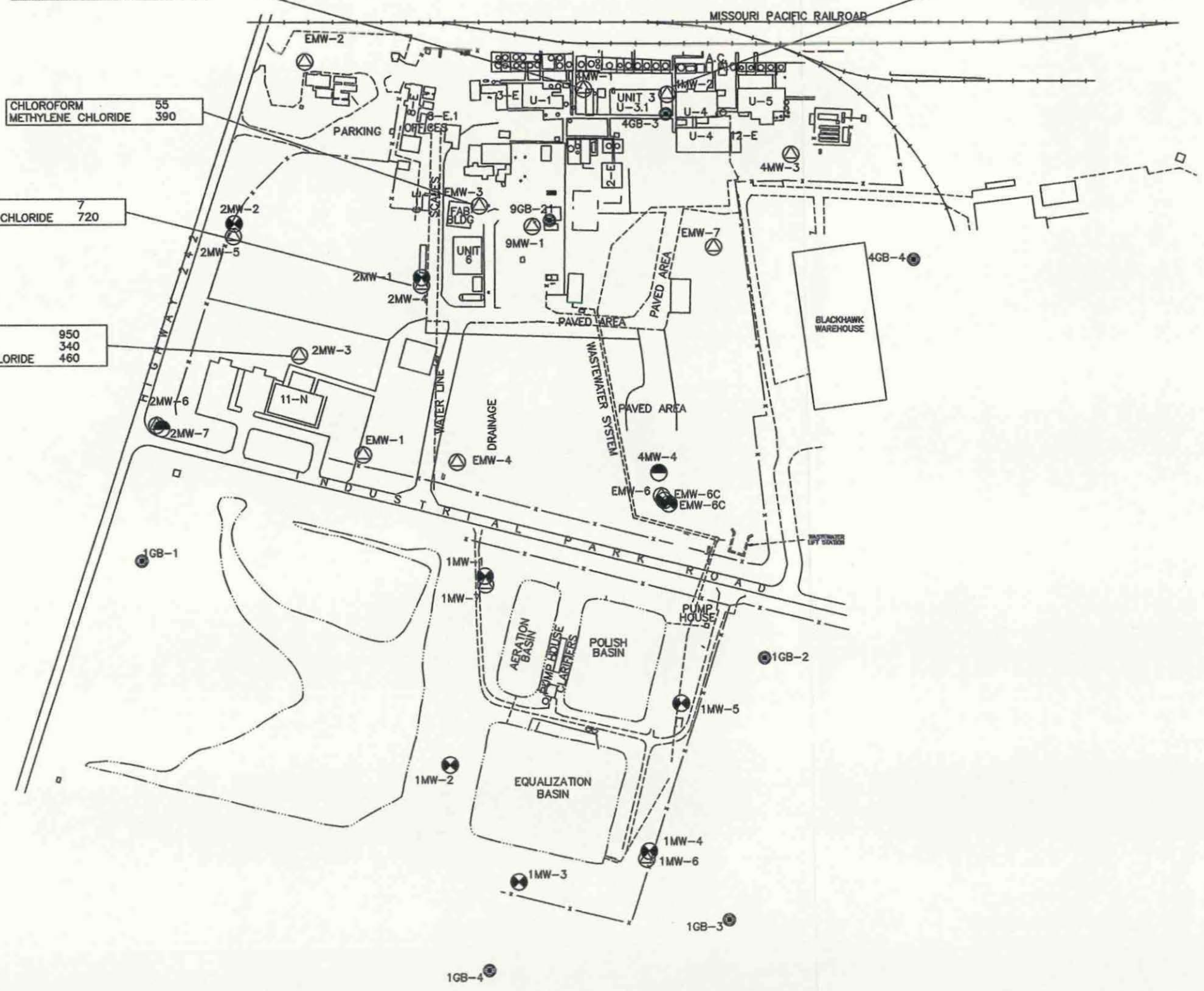
1,2 DICHLOROETHANE	960
TOLUENE	110,000
METHYLENE CHLORIDE	1,300

2,4-DINITROPHENOL	110
CHLOROFORM	1,400
BENZENE	40
METHYLENE CHLORIDE	1,300

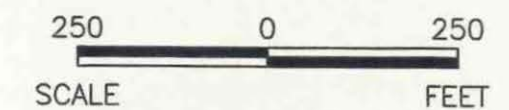
CHLOROFORM	55
METHYLENE CHLORIDE	390

BENZENE	7
METHYLENE CHLORIDE	720

PHENOL	950
CHLOROFORM	340
METHYLENE CHLORIDE	460



- LEGEND**
- - - WATER OR DRAINAGE
  - == ROAD
  - +++ RAILROAD
  - [ ] BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊗ DEEP MONITORING WELL
  - ⊙ GEOPROBE BORINGS



MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

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FIGURE 6-9  
PHASE I MISCELLANEOUS  
CONTAMINANTS IN THE  
ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162171



In general, Phase I data suggest that organic contamination (other than 1,2-dichloroethane and dinoseb) is localized. Contaminants are not present in large patterns, suggesting there are no concentrated source areas with dispersion through long-term diffusion/attenuation.

### **Inorganic Constituents**

Lead and arsenic were the only inorganic constituents identified in alluvial groundwater above MCLs. Lead concentrations consistently exceeded the MCL (15 ppb) across the entire site, ranging from 15.9 ppb in 1MW-6 to 134 ppb in 4MW-2. Arsenic was quantified above its MCL (50 ppb) in only one well, 2MW-3, at a concentration of 59.2 ppb.

Lead and arsenic also were the only inorganic compounds identified in perched groundwater above MCLs. Lead is present above its MCL in all perched wells except 1MW-4 and 2MW-1. Arsenic was detected above its MCL at 2MW-2.

In general, inorganic contaminants were consistent across the site. The contaminant distribution did not appear to be attributable to an onsite source.

### **6.2.2 Phase II Analytical Data**

Groundwater analytical data collected during Phase II activities further delineated the extent of the two primary contaminants of concern, 1,2-dichloroethane and dinoseb, in the alluvial aquifer. As in Phase I, isolated concentrations of several additional compounds were identified in areas that also had elevated 1,2-dichloroethane contamination. These compounds included phenol, 1,2-dichlorobenzene, isophorone, toluene, methylene chloride, chloroform, 1,2-dichloropropane, and 1,1,2-trichloroethane. However, only 1,2-dichloroethane and dinoseb were present across the site. Phase II groundwater data are shown in Table 6-3.



**Table 6-3**  
**Phase II Facility Investigation**  
**Groundwater Data**

[illegible]



**Table 6-3**  
**Phase II Facility Investigation**  
**Groundwater Data**

[illegible]







Table 6-3  
Phase II Facility Investigation  
Groundwater Data

Compound	1MW-4	1MW-5	1MW-6	1MW-7	1GB-1 (36')	1GB-2 (2')	1GB-2 (61.5')	1GB-2 (80')	1GB-2 (102')	1GB-3 (37.5')	1GB-3 (60')	1GB-3 (80')
Semivolatiles (ppb)												
Chlorobenzene	U	U	U	U	U	U	U	U	U	U	U	U
Phenol	U	U	U	U	U	U	U	U	U	U	U	U
2-Chlorophenol	U	U	U	U	U	U	U	U	U	U	U	U
1,2-Dichlorobenzene	U	U	U	U	U	U	U	U	U	U	U	U
2-Methylphenol	U	U	U	U	U	U	U	U	U	U	U	U
4-Methylphenol	U	U	U	U	U	U	U	U	U	U	U	U
Isophorone	U	U	U	U	U	U	U	U	U	U	U	U
4-Chloroaniline	U	U	U	6,900	U	U	U	U	U	U	U	U
Dinoseb	U	U	U	U	U	U	U	U	U	U	U	U
Metals (ppm)												
Lead	0.011	0.0052	0.0029	0.16	0.047	0.49	0.096	0.03	0.28	0.12	0.041	0.057
Arsenic	U	U	U	U	0.44	0.12	U	U	U	U	U	U



Table 6-3  
Phase II Facility Investigation  
Groundwater Data

Compound	1GB-3 (100')	1GB-4 (40')	1GB-4 (40') D	1GB-4 (60')	1GB-4 (80')	1GB-4 (107')	2MW-2	2MW-3	1GB-4 (80')	1GB-4 (107')	2MW-2	2MW-3
Volatiles (ppb)												
Methylene Chloride	U	U	U	U	U	U	U	130	U	U	U	130
Acetone	620	U	U	U	170	790	U	2,000	170	790	U	2,000
Chloroform	U	U	U	U	U	U	U	63	U	U	U	63
1,2-Dichloroethane	63	U	U	U	U	U	U	230	U	U	U	230
Bromodichloromethane	U	U	U	U	U	U	U	U	U	U	U	U
Dibromochloromethane	U	U	U	U	U	U	U	U	U	U	U	U
Benzene	U	U	U	U	U	U	U	62	U	U	U	62
Chlorobenzene	U	U	U	U	U	U	U	U	U	U	U	U
Chlorethane	U	U	U	U	U	U	U	79	U	U	U	79
Bromoform	U	U	U	U	U	U	U	U	U	U	U	U
1,2-Dichloropropane	U	U	U	U	U	U	U	U	U	U	U	U
1,1,2-Trichloroethane	U	U	U	U	U	U	U	U	U	U	U	U
4-Methyl-2-Pentanone	U	U	U	U	U	U	U	2,500	U	U	U	2,500
Toluene	U	U	U	U	U	U	U	710	U	U	U	710
Xylenes (total)	U	U	U	U	U	U	U	17	U	U	U	17



**Table 6-3**  
**Phase II Facility Investigation**  
**Groundwater Data**

[illegible]



Table 6-3  
Phase II Facility Investigation  
Groundwater Data

Compound	2MW-4	2MW-4 D	2MW-5	2MW-6	2MW-7	4MW-1	4MW-2	4MW-3	4GB-4 (80')	4GB-4 (100')	4MW-4
Volatiles (ppb)											
Methylene Chloride	U	U	U	U	U	U	1,300	150	U	U	U
Acetone	140	U	U	U	1,000	U	U	U	U	U	110
Chloroform	U	U	U	U	U	U	460	14	U	U	U
1,2-Dichloroethane	150	150	U	U	U	4,300	310	52,000	3,300	1,900	11
Bromodichloromethane	U	U	U	U	U	U	U	U	U	U	6.1
Dibromochloromethane	U	U	U	U	U	U	U	U	U	U	13
Benzene	210	240	U	U	U	U	U	U	U	U	U
Chlorobenzene	U	U	U	U	U	U	U	U	U	U	U
Chlorethane	U	U	U	U	U	U	U	U	U	U	U
Bromoform	U	U	U	U	U	U	U	U	U	U	11
1,2-Dichloropropane	U	U	U	U	U	U	U	43	U	U	U
1,1,2-Trichloroethane	U	U	U	U	U	U	U	27	U	U	U
4-Methyl-2-Pentanone	U	U	U	U	U	U	520	U	U	U	U
Toluene	21	12	U	U	U	140,000 U	U	U	U	U	U
Xylenes (total)	11	U	U	U	11	U	U	U	U	U	U



Table 6-3  
Phase II Facility Investigation  
Groundwater Data

Compound	2MW-4	2MW-4 D	2MW-5	2MW-6	2MW-7	4MW-1	4MW-2	4MW-3	4GB-4 (80')	4GB-4 (100')	4MW-4
Semivolatiles (ppb)											
Chlorobenzene	U	U	U	U	U	U	U	U	U	U	U
Phenol	U	2	U	U	U	2,400	U	U	U	U	U
2-Chlorophenol	U	U	U	U	U	110	U	U	U	U	U
1,2-Dichlorobenzene	20	22	11	15	U	820	U	U	U	U	U
2-Methylphenol	U	U	U	U	U	180	U	U	U	U	U
4-Methylphenol	U	U	U	U	U	340	U	U	U	U	U
Isophorone	U	U	U	U	U	150	U	U	U	U	U
4-Chloroaniline	140	170	U	U	U	5,800	U	U	U	U	U
Dinoseb	U	U	26	U	U	U	170,000	U	U	U	U
Metals (ppm)											
Lead	U	U	U	U	U	0.0039	U	U	0.0091	0.0071	U
Arsenic	U	U	U	U	0.049	0.075	U	U	U	U	U



Table 6-3  
Phase II Facility Investigation  
Groundwater Data

Compound	9MW-1	9GB-21 (30')	9GB-21 (45')	9GB-21 (60')	9GB-21 (75')	9GB-21 (90')
<b>Volatiles (ppb)</b>						
Methylene Chloride	4,100	5,000	U	U	U	U
Toluene	52	U	U	U	U	U
1,2-Dichloroethane	2,300	3,900	5,800	6,800	7,300	41
<b>Semivolatiles (ppb)</b>						
1,2-Dichlorobenzene	36	U	U	U	U	U
Dinoseb	18	1,000	U	U	2,800	U
<b>Metals (ppb)</b>						
Arsenic	0.12	U	U	U	U	U
Aluminum	0.15	NA	NA	NA	NA	NA
Barium	0.13	NA	NA	NA	NA	NA
Calcium	52	NA	NA	NA	NA	NA
Iron	6.5	NA	NA	NA	NA	NA
Magnesium	27	NA	NA	NA	NA	NA
Manganese	6.6	NA	NA	NA	NA	NA
Potassium	8.4	NA	NA	NA	NA	NA
Vanadium	0.056	NA	NA	NA	NA	NA
Zinc	0.0026	NA	NA	NA	NA	NA

**Notes:**

U = Not quantified above PQLs

NA = Not analyzed



### **1,2-Dichloroethane**

The compound 1,2-dichloroethane was identified above PQLs in groundwater from 14 wells and five hydropunch borings. The lateral distributions of contaminants and isocons are shown in Figure 6-10. As this figure shows, 1,2-dichloroethane is present in roughly the same plume configuration as depicted in Phase I.

Phase II sampling using Geoprobe hydropunch techniques confirmed that contamination does not extend past the wetland west of the wastewater treatment ponds or beyond the southwestern property boundary. Contamination at depth (approximately 75 and 90 feet bgs) does extend past the southeastern property boundary immediately east of the wastewater treatment ponds; hydropunch borings 1GB-2 and 1GB-3 contained contaminant concentrations ranging from 9.1 to 63 ppb at intervals of 75 and 90 feet bgs. Groundwater concentrations in the upper intervals of the alluvial aquifer in both borings were below quantitation limits.

At Site 2, 2MW-6 was installed in the upper portion of the alluvial aquifer to determine the extent of 1,2-dichloroethane contamination in groundwater west of 2MW-3. Results from this boring indicated that no 1,2-dichloroethane is present at this location above PQLs. Nor was 1,2-dichloroethane detected in adjacent deep monitoring well 2MW-7, screened approximately 150 feet bgs. Absence of the compound indicates the plume has not migrated west of the existing property boundary.

Phase II data from Site 4 (from wells 4MW-3 and 4MW-4 and Geoprobe borings 4GB-3 and 4GB-4) further delineated the extent of the high-concentration 1,2-dichloroethane plume originally detected in wells 4MW-1 and EMW-7. Contaminant concentrations in 4MW-3 are comparable to EMW-7. Geoprobe borings south of 4MW-3 also contained elevated concentrations of 1,2-dichloroethane (1,900 to 3,300 ppb) from 45 to 75 feet bgs. Deep well CED4-MW4 (not shown on Figure 6-10) indicated 11 ppb 1,2-dichloroethane at a screened depth of 150 feet bgs. These data show that 1,2-dichloroethane contamination extends beyond the



eastern property boundary and the full thickness of the alluvial aquifer in the eastern portion of the site.

Supporting data from 9GB-1 also indicate 1,2-dichloroethane contamination at depth in the central portion of the site. Contaminant concentrations increase from 3,900 ppb at 9GB-1 (30') to 7,300 ppb at 9GB-1 (75'). The fifth interval, 9GB-1 (90') was non-detect for 1,2-dichloroethane.

1,2-dichloroethane was identified in the discontinuous perched zone at Site 1 and immediately north of Industrial Park Road, the areal distribution in this zone is shown in Figure 6-11. These data are consistent with Phase I results, suggesting that the waste water treatment ponds (or ancillary treatment units/piping) at some time were a source area for 1,2-dichloroethane.

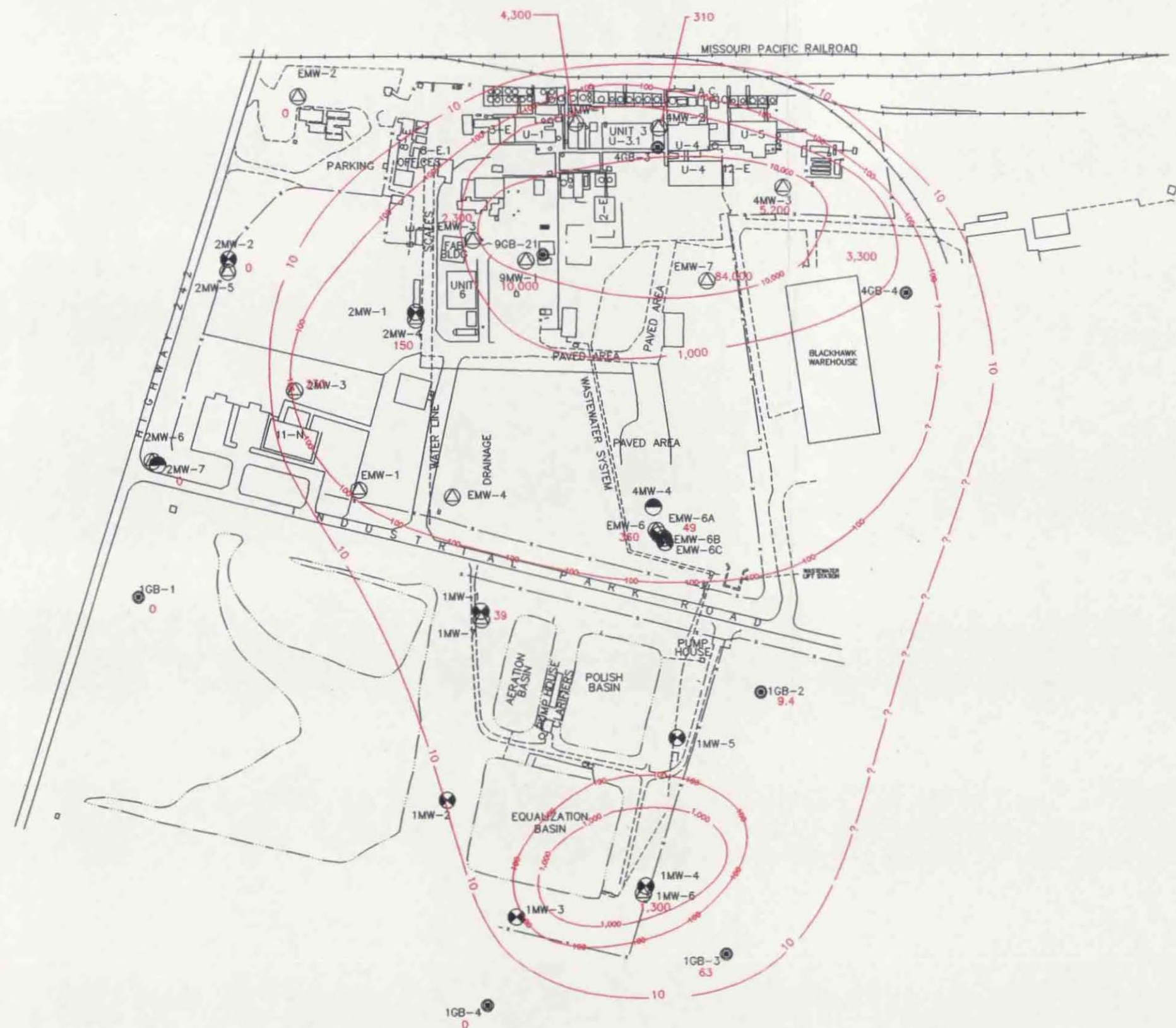
#### **Dinoseb**

Figure 6-12 shows the areal extent of dinoseb contamination in groundwater as quantified in the Phase II investigation. Dinoseb was identified in four wells and one hydropunch boring at concentrations greater than PQLs. The highest concentration was identified in 4MW-2 at 170,000 ppb; the lowest concentration was identified in 2MW-5 at 25 ppb. The plume extends from Site 9 north to Site 4. However, no source areas have been identified at Site 4 or upgradient of Site 9.

The Geoprobe boring at 9GB-1 identified dinoseb at the first interval (30 feet bgs) and at depth (75 feet bgs). Analytical results for the middle two intervals (45 feet bgs and 60 feet bgs) indicate that dinoseb concentrations were below PQLs. The presence of dinoseb at depth in the aquifer suggests that either the aquifer is contaminated from the initial interval (30 feet bgs) to 80 feet bgs (and that samples from the middle two intervals were not analyzed correctly) or that the aquifer is contaminated at depth, with an upgradient source with a sinking plume.

No dinoseb was detected in perched zone wells.





- LEGEND
- - - WATER OR DRAINAGE
  - ROAD
  - |||| RAILROAD
  - BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊗ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - DEEP MONITORING WELL
  - ⊙ GEOPROBE BORINGS
  - - - CONTAMINANT ISOCONS (PPB)
  - - - ISOCON INFERED

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

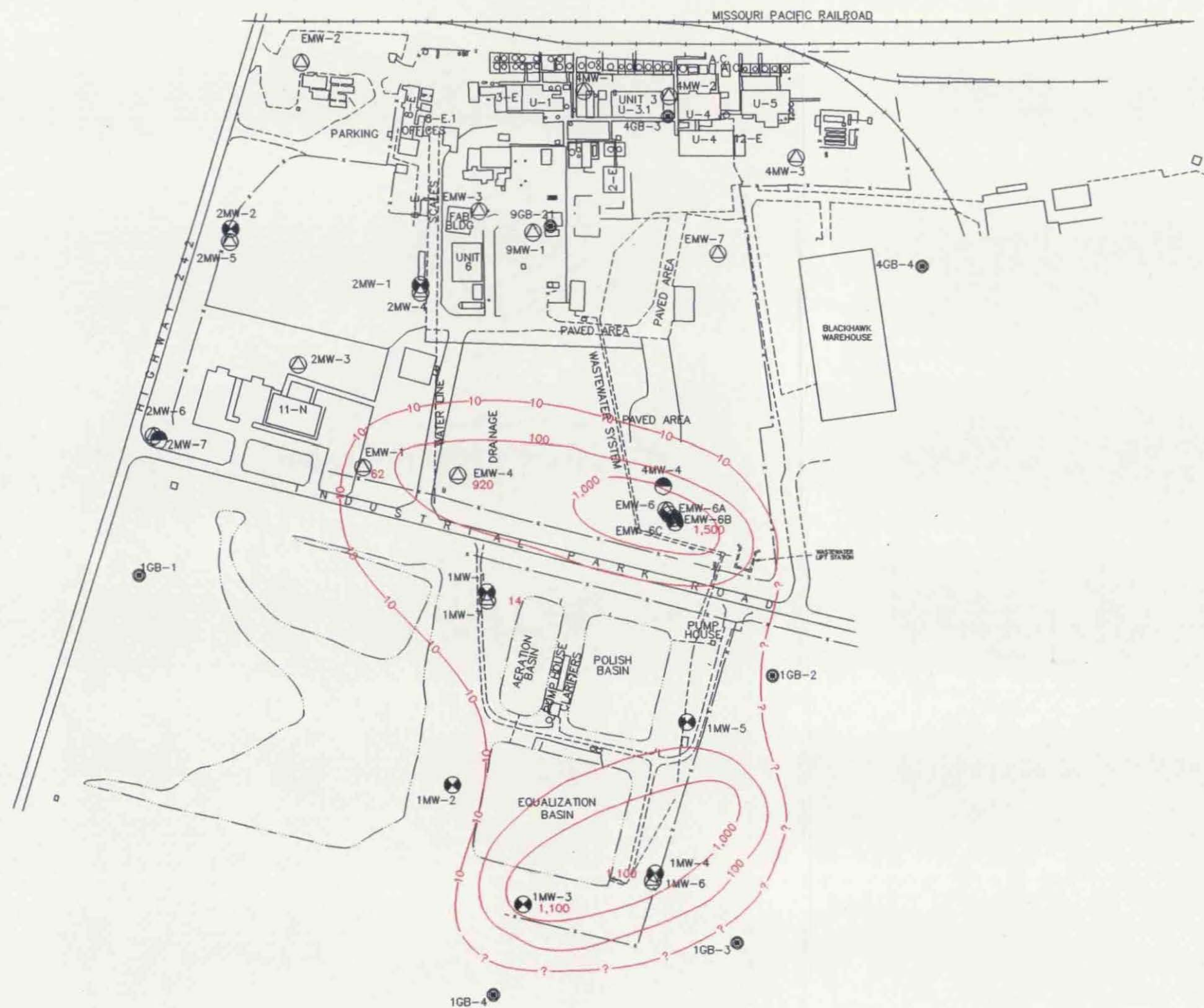
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FIGURE 6-10  
PHASE II  
1,2 DICHLOROETHANE CONCENTRATIONS  
IN THE ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162172





- LEGEND
- - - WATER OR DRAINAGE
  - == ROAD
  - +++ RAILROAD
  - BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊗ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊖ DEEP MONITORING WELL
  - ⊙ GEOPROBE BORINGS
  - - - CONTAMINANT ISOCONS (PPB)
  - - - ISOCON INFERRED

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

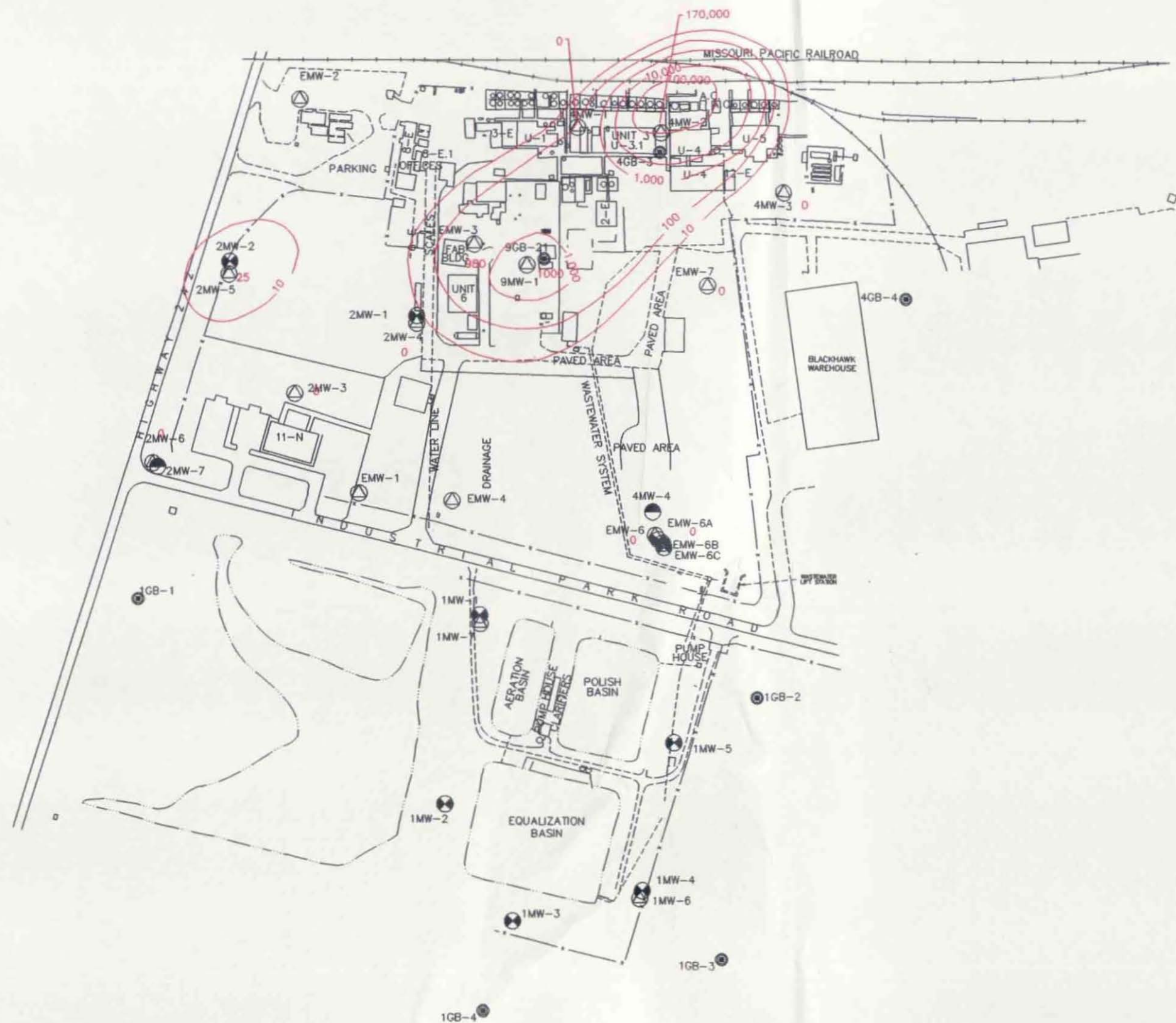
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FIGURE 6-11  
PHASE II  
1,2-DICHLOROETHANE CONCENTRATIONS  
IN THE PERCHED AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATIONS

DWG DATE: 06/27/96 DWG NAME: C2162174





- LEGEND**
- WATER OR DRAINAGE
  - == ROAD
  - +++ RAILROAD
  - BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊗ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊖ DEEP MONITORING WELL
  - ⊙ GEOPROBE BORINGS
  - CONTAMINANT ISOCONS (PPB)
  - ? ISOCON INFERRED

250 0 250  
SCALE FEET

MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

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NASHVILLE, TN, PENSACOLA, FL, AND RALEIGH, NC.

FIGURE 6-12  
PHASE II  
DINOSEB CONCENTRATIONS IN THE  
ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/27/96 DWG NAME: C2162175



### **Miscellaneous Organic Compounds**

Figure 6-13 identifies compounds quantified above the appropriate MCLs at different locations in the alluvial aquifer. As with Phase I data, there is no noticeable spatial relationship between these exceedances. All exceedances occur in the presence of 1,2-dichloroethane contamination. The primary location of commingled volatile contaminants is 4MW-1, which contains toluene (140,000 ppb), isophorone (150 ppb), 1,2-dichlorobenzene (820 ppb), and phenol (2,400 ppb).

### **Inorganic Constituents**

As with Phase I data, lead and arsenic were consistently identified above MCLs in groundwater samples collected from the alluvial aquifer. Arsenic concentrations ranged up to 440 ppb in hydropunch boring 1GB-1. Lead was quantified at up to 490 ppb in hydropunch boring 1GB-2 (30').

In general, inorganic contaminant concentrations were consistent across the site. The contaminant distribution did not appear to be attributable to an onsite source.

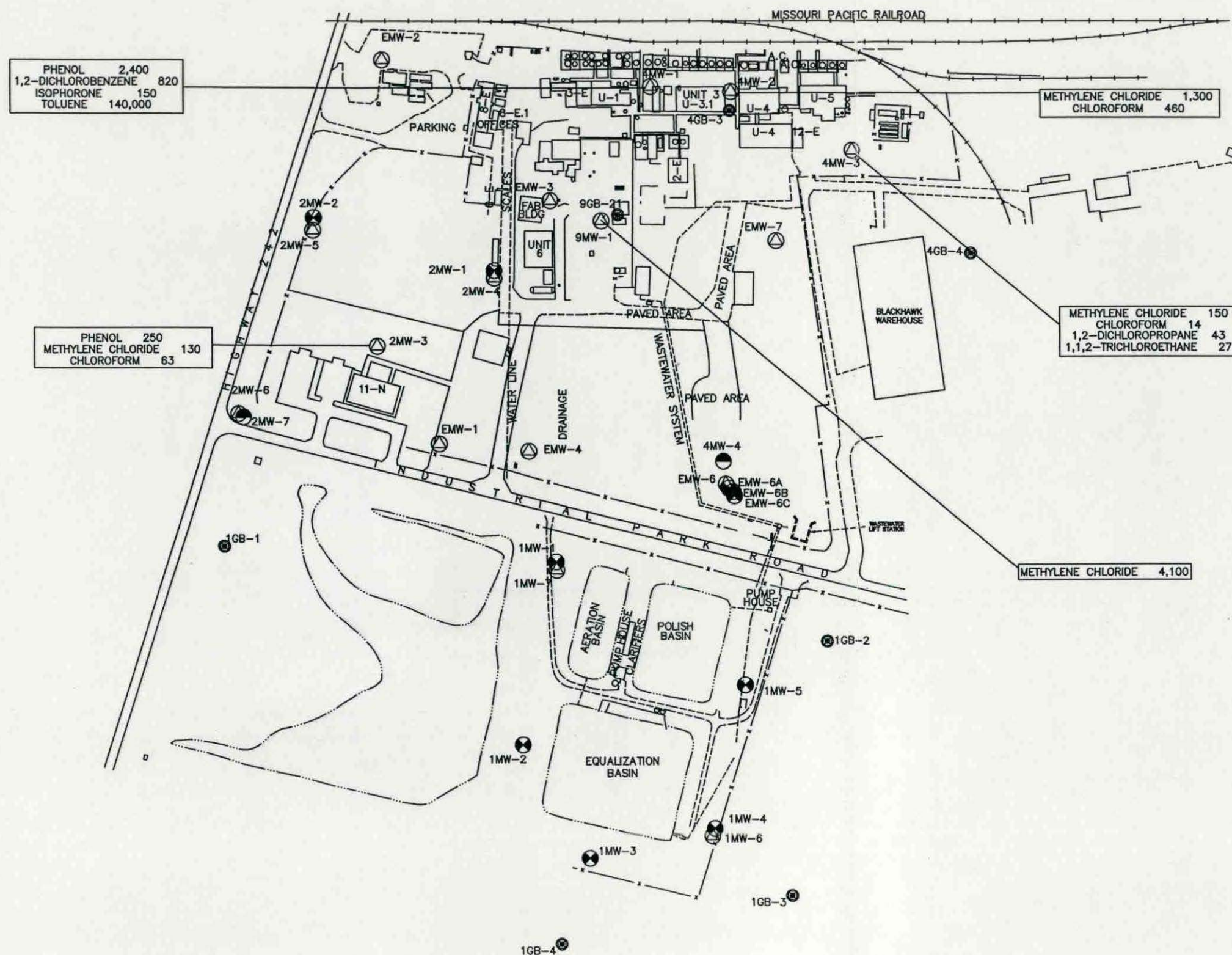
### **Total Contaminant Isopleths**

Total VOC and SVOC isopleths for the alluvial aquifer are presented in Figures 6-14 and 6-15. Isopleths for the perched zone are shown in Figures 6-16 and 6-17. Phase II data were used to generate total isopleth maps as they represented the most complete analytical dataset onsite. These data represent a "snapshot" of total groundwater conditions.

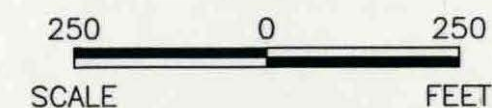
#### **6.2.3 Phase III Data**

As discussed in Section 4, additional sampling was conducted offsite to determine the extent of 1,2-dichloroethane contamination. This investigation comprised two phases: Geoprobe groundwater sampling and offsite monitoring well installation.





- LEGEND**
- WATER OR DRAINAGE
  - == ROAD
  - ++++ RAILROAD
  - ▭ BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPRPOX.)
  - MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - ⊗ DEEP MONITORING WELL
  - ⊕ GEOPROBE BORINGS



MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

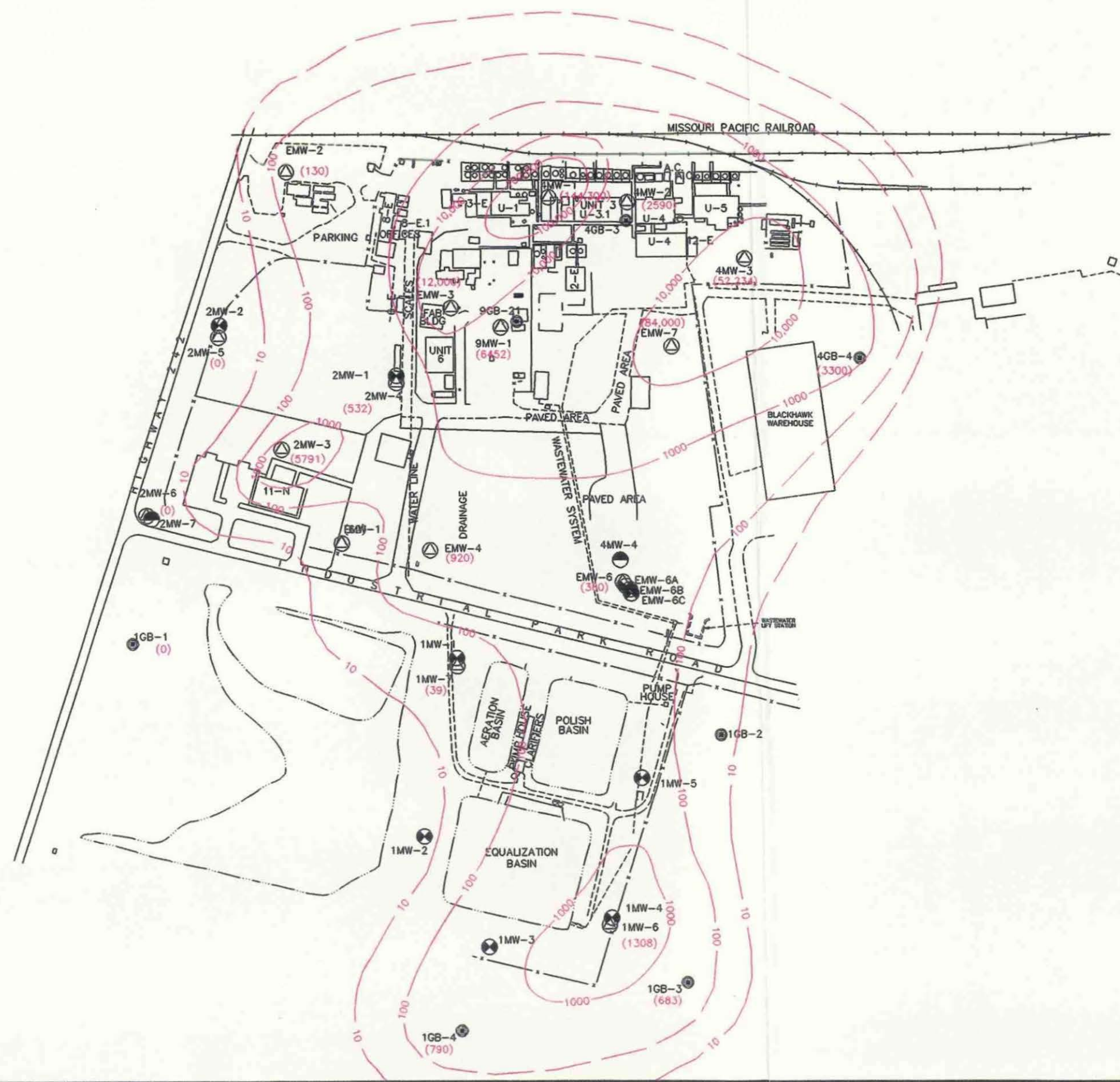
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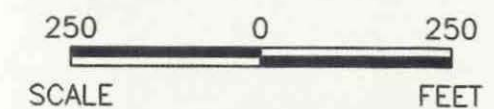
FIGURE 6-13  
PHASE II  
MISCELLANEOUS CONTAMINANTS IN THE  
ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162177





- LEGEND**
- - - WATER OR DRAINAGE
  - == ROAD
  - +++ RAILROAD
  - ▭ BUILDING
  - - - FENCE
  - - - SUBSURFACE PIPING (APPROX.)
  - ⊗ MONITORING WELL
  - ⊙ SHALLOW MONITORING WELL
  - DEEP MONITORING WELL
  - ⊙ GEOPROBE BORINGS
  - (790) - TOTAL VOC CONCENTRATION (PPB)
  - - - 100 - - CONTAMINATION ISOCONS (PPB)



MAP SOURCE: DELTA PROCESS MANAGEMENT, INC.

Environmental and Safety Designs, Inc.

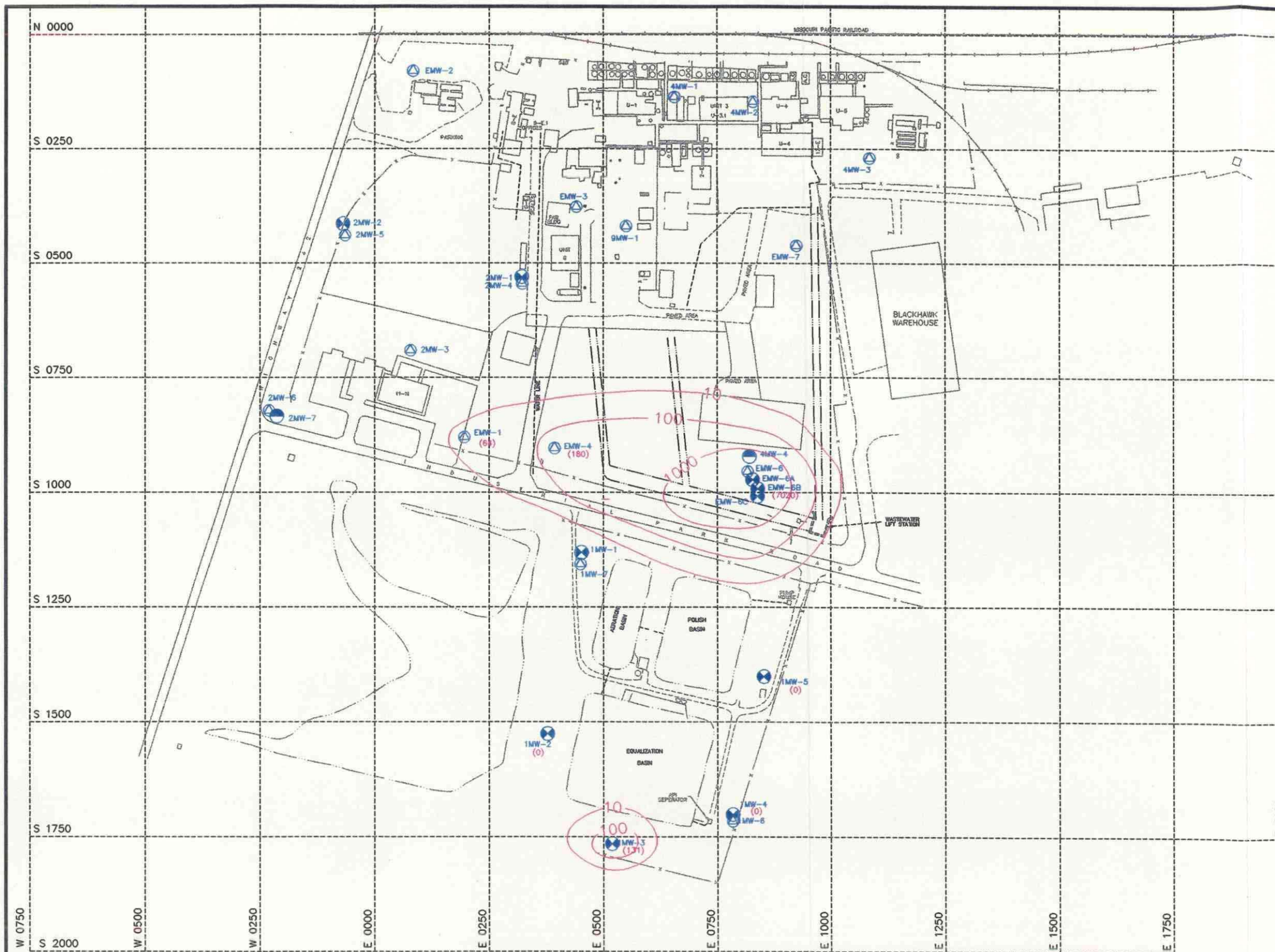


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FIGURE 6-14  
PHASE II TOTAL VOCs  
ALLUVIAL AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE: 06/28/96 DWG NAME: C2162VC7





- LEGEND
- WATER OR DRAINAGE
  - ROAD
  - TRAIL
  - SIDEWALK
  - RAILROAD
  - BUILDING
  - FENCE
  - SUBSURFACE PIPING (APPROX.)
  - MONITORING WELL
  - SHALLOW MONITORING WELL
  - DEEP MONITORING WELL
  - 10 - CONTAMINATION ISOCON (PPB)

225 0 225  
SCALE FEET

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FIGURE 6-17  
PHASE II TOTAL SVOC  
CONCENTRATIONS IN THE  
PERCHED AQUIFER  
CEDAR CHEMICAL  
FACILITY INVESTIGATION

DWG DATE:06/28/96 DWG NAME:C2162P2S



### **Geoprobe Groundwater Sampling**

Nineteen Geoprobe borings were completed south and east of the site to determine the horizontal extent of 1,2-dichloroethane contamination; samples were collected at multiple depths in each boring to refine the vertical extent characterization. Results for offsite screening samples are presented in Table 6-4.

Results of the Geoprobe groundwater samples indicated that the plume extends approximately 0.9 mile offsite to the south-southeast, based on detectable quantities of 1,2-dichloroethane in the samples collected with the Geoprobe rig. Vertical characterization data indicate the plume is detectable between 80 and 100 feet bgs; data from upper intervals (40 to 60 feet bgs) indicate 1,2-dichloroethane is below detectable concentrations. This is consistent with classical conceptual models for DNAPL sites.

### **Offsite Well Sampling Results**

As discussed in Section 4, four monitoring wells were installed downgradient of the plume to confirm Geoprobe results. Two wells were screened at the top of the Jackson clay to monitor for the presence of DNAPL as well as the dissolved-phase contaminants in high-conductivity gravels. Two wells were screened starting approximately 30 feet above the Jackson clay to monitor both DNAPL and dissolved-phase contaminants.

No SVOCs were detected in any offsite wells. Detectable quantities of VOCs were observed only in well OFFMW-2, which exhibited a 1,2-dichloroethane concentration of 110 ppb and a 2-butanone concentration of 77 ppb. The inorganic results indicated trace concentrations of cadmium in all wells except OFFMW-1. The highest quantifiable concentration of cadmium was in well OFFMW-2 at 0.006 ppm. Based on the analytical results for the samples collected from wells OFFMW-3 and OFFMW-4, the high headspace readings recorded prior to sampling most likely result from naturally occurring methane. The lignite detected at the surface of the Jackson Clay is the most probable methane source.



Table 6-4  
 Offsite Groundwater Results for 1,2-Dichloroethane (ppb)

Sample Number	Screening Concentration	Verification Concentration
1GB-5 (40')	<5	—
1GB-5 (60')	<5	—
1GB-5 (80')	<5	—
1GB-5 (100')	300	—
1GB-6 (40')	<5	—
1GB-6 (60')	<5	—
1GB-6 (80')	<5	—
1GB-6 (100')	21	—
1GB-7 (40')	<5	—
1GB-7 (60')	<5	—
1GB-7 (80')	<5	—
1GB-7 (100')	200	150
1GB-8 (80')	<5	—
1GB-8 (100')	60	—
1GB-9 (78')	<5	—
1GB-9 (98')	43	—
1GB-10 (80')	<5	—
1GB-10 (100')	34	—
1GB-11 (80')	64	—
1GB-11 (100')	43	—
1GB-12 (80')	<5	—
1GB-12 (100')	<5	—
1GB-12 (120')	<5	U
4GB-5 (40')	<5	—
4GB-5 (60')	2,000	—



Table 6-4  
 Offsite Groundwater Results for 1,2-Dichloroethane (ppb)

Sample Number	Screening Concentration	Verification Concentration
4GB-5 (80')	720	—
4GB-5 (100')	230	—
4GB-6 (40')	<5	—
4GB-6 (60')	36	—
4GB-6 (80')	1,100	—
4GB-6 (100')	2	—
4GB-7 (60')	<5	—
4GB-7 (80')	5,300	3,700
4GB-7 (100')	67	—
4GB-8 (80')	26	—
4GB-8 (100')	6,700	—
4GB-8 (122')	2,100	—
4GB-9 (80')	<5	—
4GB-9 (100')	<5	—
4GB-9 (118')	<5	U
4GB-10 (80')	<5	—
4GB-10 (100')	<5	—
4GB-10 (134')	<5	U
4GB-11 (80')	<5	—
4GB-11 (100')	<5	—
4GB-11 (126')	<5	—
4GB-12 (80')	<5	—
4GB-12 (100')	<5	U



Table 6-4  
Offsite Groundwater Results for 1,2-Dichloroethane (ppb)

Sample Number	Screening Concentration	Verification Concentration
PZ-5 <sup>a</sup>	<5	—
BH-1 <sup>b</sup>	3,200	U
BH-1-02	1,300	1,600

**Notes:**

- a = PZ represents a piezometer. A piezometer located in the extreme western corner of the plant was sampled as a monitoring well.
- b = BH represents the Blackhawk irrigation well. There were conflicting results between the field GC and contract laboratory for sample BH-1, therefore the well was resampled. The second sample was labelled BH-1-02.
- = Sample was not submitted for verification sampling.
- U = Not quantified above PQLs.

These data indicate that the dissolved contaminant plume is present at concentrations above MCLs approximately 0.9 mile downgradient at approximately 80 feet bgs. Data from both monitoring wells and the Geoprobe investigation were used to develop the offsite plume map shown in Figure 6-18. This figure shows the areal extent of contamination south of the Cedar Chemical facility. Figure 6-19 is a graphical presentation of the vertical extent of contamination using well and Geoprobe data; these data suggest that the 1,2-dichloroethane plume is present in deeper portions of the aquifer downgradient of the property, a configuration is typical of DNAPL plumes.

As stated in Section 4, the offsite well sampling is part of the baseline groundwater sampling event. The analytical results for the offsite well pairs is presented in the tables for the baseline sampling event.

#### 6.2.4 Baseline Groundwater Sampling Event Results

As discussed in the *Quarterly Groundwater Monitoring Report* (EnSafe, June 1996), 32 wells were sampled during April 1996 for total organic carbon (TOC) and total organic halides (TOX)



to monitor the status of the groundwater plume. Nine wells were sampled concurrently for VOCs and SVOCs. Results for wells sampled for VOCs and SVOCs are presented in Table 6-5. Please refer to the quarterly monitoring reports for TOX and TOC data.

These baseline concentrations will be compared with the results from the four quarters of groundwater monitoring to be completed during 1996 and early 1997.

### **6.3 Preliminary Hydrogeological Assessment**

During Phase II investigations, aquifer parameters were assessed in seven alluvial wells (2MW-6, 1MW-6, EMW-3, 2MW-5, EMW-2, 1MW-7, and 4MW-3) and two perched zone wells (1MW-4 and 1MW-1) using slug-testing techniques. Monitoring well 2MW-7, screened in a deeper portion of the alluvial aquifer, was also tested. Slug tests were conducted to provide preliminary estimates of onsite aquifer characteristics. Using slug tests to characterize the aquifer (instead of pump test or specific capacity tests) offered the added benefit of reduced IDW.

#### **6.3.1 Slug Test Data**

A Teflon slug was used to displace water within the well casing above static level. A pressure transducer and an automatic datalogger were used to monitor re-equilibration in the well. Two tests were conducted on each well:

- A falling-head (injection) slug test was accomplished by adding a known volume (the slug) to the well and observing water levels returning (falling) to the static level;
- A rising-head (withdrawal) slug test was accomplished by removing a known volume (slug) from the well and observing water levels returning (rising) to the static level.



Table 6-5  
Baseline Groundwater Sampling Event  
Full Scan Results (ppb)

	2MW-6	4MW-2	EMW-7	BH-1-01 Blackhawk Ag Well	OFFMW-1	OFFMW-2	OFFMW-3	OFFMW-4
Volatile Organic Compounds								
Acetone	43	U	U	U	U	U	U	U
2-Butanone	U	13	U	U	U	77	U	U
Carbon Disulfide	U	14	U	U	U	U	U	U
Chloroform	U	760	U	U	U	U	U	U
Chlorobenzene	U	U	10	U	U	U	U	U
1,2-Dichlorobenzene	17	76	U	U	U	U	U	U
1,2-Dichloroethane	U	260	87,000	1,200	U	110	U	U
trans-1,2-Dichloroethane	U	U	10	U	U	U	U	U
Methylene Chloride	U	460	U	U	U	U	U	U
Vinyl Acetate	U	U	10	U	U	U	U	U
Xylene (total)	U	12	U	U	U	U	U	U
o-Xylene	U	U	10	U	U	U	U	U



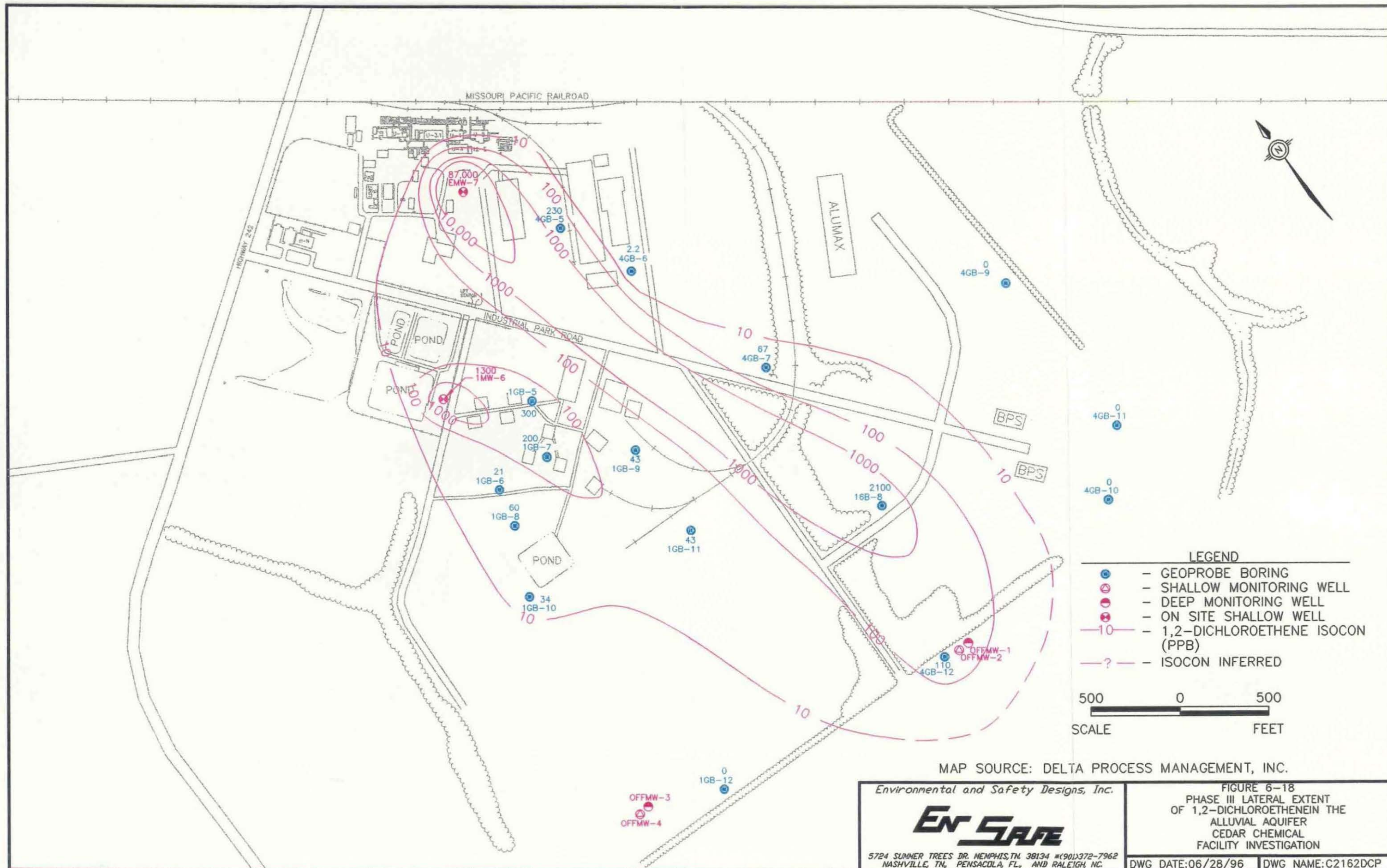
Table 6-5  
 Baseline Groundwater Sampling Event  
 Full Scan Results (ppb)

	2MW-6	4MW-2	EMW-7	BH-1-01 Blackhawk Ag Well	OFFMW-1	OFFMW-2	OFFMW-3	OFFMW-4
Semivolatile Organics								
3,4-Dichloroaniline	44	U	U	U	U	U	U	U
1,2-Dichlorobenzene	11	U	U	U	U	U	U	U
Dinoseb	U	54,000	33	U	U	U	U	U

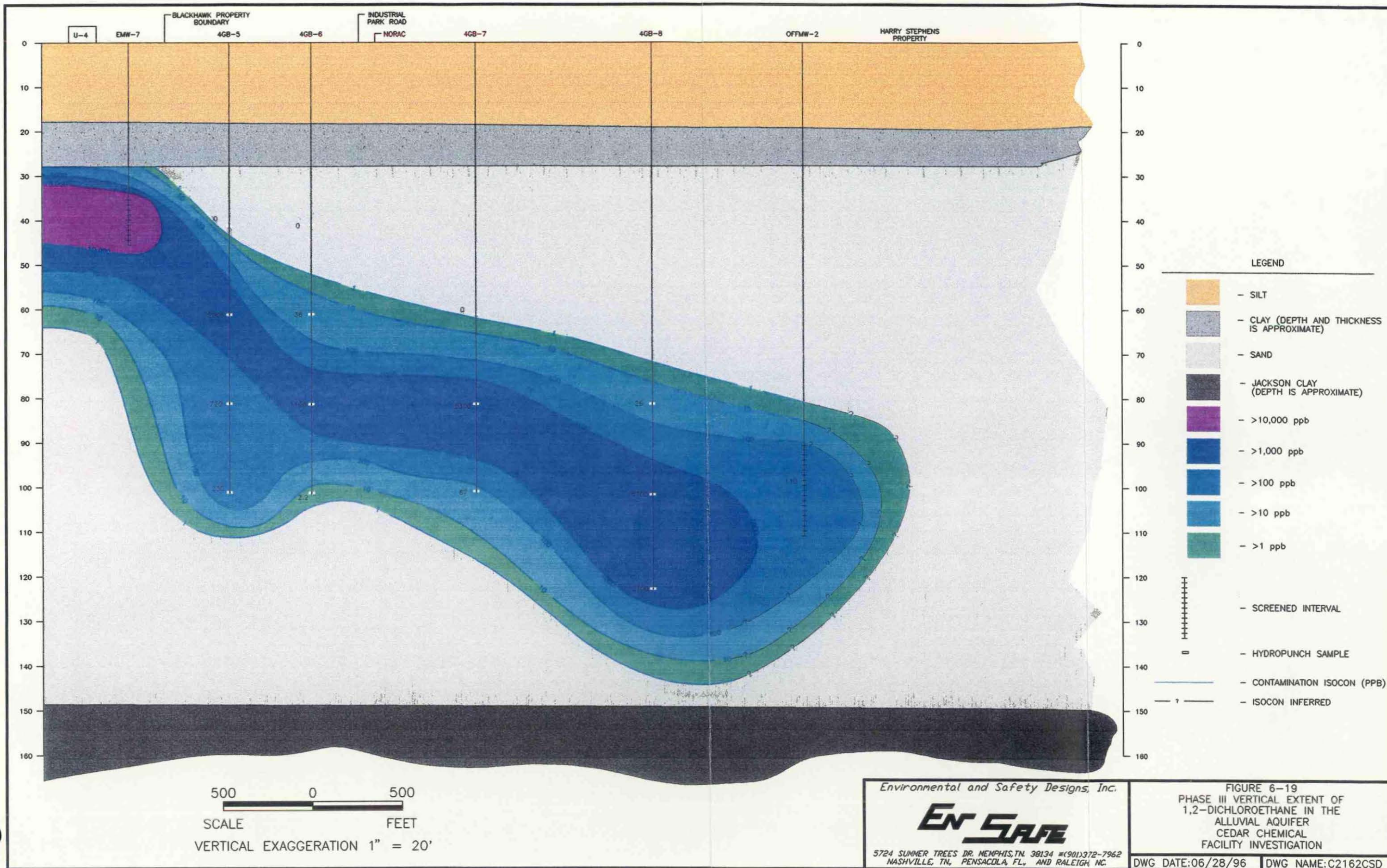
**Note:**

U = Not quantified above PQLs.











Once the water level returned to nearly static levels (equilibrated), the test was terminated and the slug was removed from the well. Drawdown data for all wells are presented in Appendix D. In one well, 4MW-3, four tests were run (two falling head, two rising head) due to the rapid water level recoveries observed in this well. Data for the second set of tests are presented separately as they were produced by using larger groundwater displacements.

Aquifer parameters were derived from slug test data using the Cooper, Bredehoeft, Papadopoulos modification to the Theis solution (1967) or the Bouwer and Rice (1976) solution for the alluvial (confined) aquifer. The Bouwer and Rice solution for unconfined aquifers was used for perched zone wells. These methods apply curve-matching procedures to determine aquifer properties. Compliance with solution assumptions is discussed in Table 6-6.

A curve-matching computer solution (AQTESOLV, 1989) was applied to slug test data to estimate the transmissivity (T) and storativity (S) from field data. Slug test analyses of these parameters vary with changes in drawdown, casing radius, effective radius, the aquifer thickness, the length of the well screen, and the static height of the water column. However, storativity estimated using slug tests may be erroneous because of the effects of storativity in the filter pack. Although it depends upon the borehole diameter, slug tests typically do not stress the aquifer matrix adequately to overcome these effects.

Transmissivity and hydraulic conductivity values estimated using the Bouwer and Rice and Cooper (et al.) methods are presented in Table 6-7. Solution graphs developed using the AQTESOLV package are included in Appendix E to show goodness-of-fit.



Table 6-6  
Slug Test Solution Assumptions

Assumption	Solution Method	Met?	Comment
Aquifer has infinite areal extent.	Cooper (et al.), Bouwer	Yes	Regional data indicate this aquifer is contiguous for several miles around the site.
Aquifer is homogeneous, isotropic, and of uniform thickness.	Cooper (et al.), Bouwer	No	The aquifer is not homogeneous, but coarsens with depth. The aquifer is a uniform thickness (120 to 130 feet thick) across the site.
Aquifer potentiometric surface is initially horizontal.	Cooper (et al.), Bouwer	Yes	The hydraulic gradient at the site is 0.00005 feet, or very nearly horizontal.
A volume of water, V, is injected into or discharged from the well instantaneously.	Cooper (et al.), Bouwer	Yes	—
Test well is fully penetrating.	Cooper (et al.)	No	All wells at the Cedar Chemical facility are partially penetrating.
Flow to test well is horizontal.	Cooper (et al.)	Yes	All flow is assumed to be radial.
Aquifer is confined.	Cooper (et al.), Bouwer	Yes	—
Water is released instantaneously from storage with decline of hydraulic head.	Cooper (et al.)	Yes	Assumed true in a confined aquifer.

*Notes:*

— = None

For comparative purposes, transmissivity estimates can be used to derive hydraulic conductivity:

$$K = \frac{T}{B}$$

where  $K$  is the conductivity (ft/day),  $T$  is the transmissivity (ft<sup>2</sup>/day), and  $B$  is the thickness of the aquifer (ft). This equation requires use of consistent units.



As can be seen in Table 6-7, the Bouwer-Rice solution gave consistently higher transmissivity estimates than the Cooper (et al.) solution. Transmissivities ranged from 110 ft<sup>2</sup>/day (820 gallons per day per foot [gpd/ft]) to 30,000 ft<sup>2</sup>/day (220,000 gpd/ft). The geometric mean transmissivity calculated using the Bouwer-Rice solution is 1,069 ft<sup>2</sup>/day (8,000 gpd/ft). Storativity estimates from these analyses ranged from  $1 \times 10^{-9}$  to 0.3. Confined aquifer storativities typically range from 0.001 to 0.00001 ( $1 \times 10^{-5}$ ).

Phase II values are typically higher than those presented in the GG&H report of July 1988. These values were approximately 8,500 ft<sup>2</sup>/day (64,000 gpd/ft) in the deeper portion of the alluvial aquifer, and 270 ft<sup>2</sup>/day (1,270 gpd/ft) in the shallow portions of the alluvial aquifer. Many factors can account for the variability seen between the two studies, particularly well construction details.

In general, slug test data underestimate aquifer parameters in a highly transmissive aquifer if the filter pack and screen slots are not sized correctly, if the well is not developed adequately (such as with a 2-inch diameter well drilled using mud rotary techniques), or if the slug does not cause a large displacement in the well. These are all potential scenarios at this site, particularly in deep alluvial well CED2-MW7 due to the large grain size in the lower part of the aquifer.

In addition, most alluvial wells are screened immediately below the surficial clay. The upper portion of the screened interval in some wells may contain a higher silt or clay content (as discussed in previous sections, the aquifer material coarsens with depth). Thus, aquifer parameters estimated from these wells are more representative of the upper portion (less transmissive portion) of the aquifer.



**Table 6-7**  
**Phase II Slug Test Data**

Well ID	Type of Test	Bouwer/Rice Solution		Cooper/Bredehoeft/Papadopoulos Solution	
		K (ft/day)	T (ft <sup>2</sup> /day)	T (ft <sup>2</sup> /day)	S
Shallow Alluvial Aquifer (Confined, B = 120 feet)					
1MW-6	Falling	1.44	172.80	0.186	0.05
	Rising	0.92	110.40	3.6	1 x 10 <sup>-8</sup>
1MW-7	Rising	36.27	4,352.40	241.63	1 x 10 <sup>-5</sup>
2MW-5	Falling	205.63	24,675.60	381.31	1 x 10 <sup>-5</sup>
	Rising	254.59	30,550.80	333.94	1 x 10 <sup>-5</sup>
2MW-6	Falling	1.47	176.40	33.87	0.001
	Rising	21.23	2,547.60	33.48	0.001
EMW-2	Falling	2.74	328.80	75.18	1 x 10 <sup>-5</sup>
	Rising	3.49	418.80	108.22	1 x 10 <sup>-9</sup>
Perched Zone (Unconfined, B variable)					
1MW-1	Falling	5.06	—	—	—
	Rising	5.40	—	—	—
1MW-4	Falling	3.70	—	—	—
	Rising	3.00	—	—	—
Deep Alluvial Aquifer (Confined, B = 120 feet)					
2MW-7	Falling	6.22	746.40	16.83	0.3
	Rising	6.00	720.00	66.83	1 x 10 <sup>-9</sup>

*Note:*

— = None estimated



### 6.3.2 Regional Aquifer Characterization

The alluvial sands are a major source of groundwater for agricultural use in eastern Arkansas, usually yielding more than 500 gpm (Todd, 1983). The alluvial aquifer grades from a silty sand at the base of the surficial clays to a basal gravel at the Jackson Clay interface. This gradation sequence is typical for eastern Arkansas. Literature cites transmissivities of up to 35,500 ft<sup>2</sup>/day (265,500 gpd/ft) in this region (USGS, 1982). The Jackson Clay acts as the lower aquitard for this aquifer, and isolates it from the underlying primary drinking water source, the Sparta Sand, by several hundred feet.

Studies in Phillips County have characterized alluvial aquifer parameters as follows:

Transmissivity	34,400 ft <sup>2</sup> /day to 35,500 ft <sup>2</sup> /day
Hydraulic Conductivity	247 ft/day to 320 ft/day
Storativity	0.0001 to 0.026
Flow Rate	840 gpm to 2,320 gpm
Specific Capacity	120 gallons per minute per foot (gpm/ft) to 129 gpm/ft

Source: *Alluvial Aquifer of the Cache and St. Francis River Basin, Northeastern Arkansas*,  
USGS and the Arkansas Geological Commission, 1982

The upper range (30,000 ft<sup>2</sup>/day) of Phase II aquifer characterization data agrees with published data on yield in the Quaternary alluvial aquifer. These extremely high transmissivity estimates are borne out by the presence of three high-volume (800 to 1,000 gpm) agricultural wells within one mile of the Cedar Chemical facility.

In conclusion, regional groundwater data indicate that the alluvial aquifer is very transmissive. Agricultural wells close to the site can sustain high flow rates (up to 1,000 gpm).



### 6.3.3 Groundwater Velocity

Assuming that aquifer parameters are in the range of 30,000 ft<sup>2</sup>/day (transmissivity) and 273 ft/day (hydraulic conductivity, assuming an aquifer thickness of 110 feet), groundwater velocities beneath the site may be calculated using Darcy's Law:

$$v = - \frac{K i}{n_e}$$

where  $K$  is the hydraulic conductivity,  $n_e$  is the effective porosity of the aquifer, and  $i$  is the hydraulic gradient. Once again, this equation assumes consistent units. The effective porosity is typically less than the actual porosity, which can range from 10% to 35% for sand and gravel materials (Driscoll, 1986), due to surface tension and frictional losses around the pore edges. The effective porosity for this equation was arbitrarily selected to be 20%.

This equation gives the following:

$$v = \frac{273 (0.0006)}{0.2} = 0.82 \text{ ft/day}$$

Therefore, expressed in terms of years, the average calculated velocity of groundwater equals a rate of 299 feet/year in the lower alluvial aquifer.







## **7.0 CONCLUSIONS**

### **7.1 Soil**

Soil contamination was detected at several locations at the Cedar Chemical facility. Contamination detected at some of the sites is the result of releases from past site operations, such as the former waste treatment ponds (Site 2) and the former Dinoseb disposal ponds (Site 9). Soil contamination detected at several other sites was less severe and appears to be isolated. The following sections summarize the extent of soil contaminants at each site and recommendations for any further action, if required.

#### **7.1.1 Site 1 — Wastewater Treatment Ponds**

Several inorganic and organic contaminants were detected in the soil samples collected from the hand auger and monitoring well borings installed onsite. One of the hand auger samples (1HA-4), collected adjacent to wastewater tank 2, contained 1,500 ppm of 3,4-dichloroaniline. Hand auger samples collected 12 feet bgs during the Phase II FI did not detect 3,4-dichloroaniline, indicating that the contamination is limited to the surface soil here. Sediment samples from the ponds also contained high concentrations (910 ppm to 1,200 ppm) of 3,4-dichloroaniline.

A baseline risk assessment should be conducted at this site to develop soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants will be assessed to determine if remediation is required.

#### **7.1.2 Site 2 — Former Waste Treatment Ponds**

Several contaminants were detected in the soil samples collected from the former waste treatment ponds. Methylene chloride and 1,2-dichloroethane were the contaminants most frequently detected at high concentrations in this area. Figures 5-2 and 5-3 presented in Section 5 of this report present the horizontal areal distribution and extent of these contaminants at this site. The contamination extends vertically to a maximum of 20 to 30 feet bgs. Other contaminants



detected at this site are more isolated and primarily exist within the same area shown for methylene chloride and 1,2-dichloroethane.

Some organic contaminants were also detected in the soil samples collected from the monitoring well borings, but generally in lower concentrations. Analytical results for the Phase III methoxychlor confirmation sample the from monitoring well 2MW-7 boring were negative. Samples collected from the areas of stressed vegetation extending off Site 2 exhibited detectable concentrations of compounds similar to those within the boundaries of Site 2.

A baseline risk assessment should be conducted to develop soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants will be assessed to determine if remediation is required.

#### **7.1.3 Site 3 — Storm Water Ditches**

Numerous contaminants were detected in the sediment samples collected from the storm water ditches during the Phase I investigation. Only half of the samples collected from the native material beneath the storm water ditch sediments exhibited detectable concentrations of site constituents. Phase II soil samples from beneath the sediments indicated that very few of these contaminants are migrating into the underlying soil. The most consistently encountered contaminant in the ditch sediments and soil was methoxychlor.

Dinoseb contamination was encountered near the ditches while installing a lithologic boring. The characteristic yellow staining was detected from 4 to 8 feet bgs. Dinoseb concentrations in this interval ranged from 180 ppm to 13,000 ppm.

A baseline risk assessment should be conducted to develop soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants at this site will be assessed to determine if remediation is required.



#### **7.1.4 Site 4 — Rail Spur Loading/Unloading Area**

During the Phase I FI, numerous contaminants were detected in the hand auger samples collected along the rail spur, where material is loaded and unloaded. Methoxychlor, Dinoseb, and 3,4-dichloroaniline were the compounds most consistently detected at high concentrations. Soil borings installed to 30 feet bgs and sampled during the Phase II FI indicated that most of the soil contamination in this area was limited to the top 5 feet of soil.

A baseline risk assessment should be conducted to develop soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants at this site will be assessed to determine if remediation is required.

#### **7.1.5 Site 5 — Maintenance Services Drum Vault**

Soil samples collected beneath the drum vault did not indicate that material stored there has impacted underlying soil. Dinoseb was detected in one sample from beneath the vault, but this detection is most likely associated with the former Dinoseb disposal ponds that were adjacent to this area. No further action should be required at this site.

#### **7.1.6 Site 6 — Area of Concern 1**

Site 6 comprises primarily the nonproduction areas on the south side of the property. Phase I and II sampling events included installing and sampling several soil borings in this area to delineate the nature and extent of soil contamination across the site. Numerous contaminants were detected in the soil samples; however, Dinoseb was the only contaminant encountered consistently. The other contaminants identified at this site appear to be isolated and very limited in extent.

A baseline risk assessment should be conducted to develop soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants at this site will be assessed to determine if remediation is required.



#### **7.1.7 Site 9 — Former Dinoseb Disposal Ponds**

The areal extent of Dinoseb associated with the former disposal ponds was delineated during the Phase I FI. Figures 5-20, 5-21, and 5-22 in Section 5 of this report illustrate the lateral extent of the Dinoseb contamination. Three soil borings installed to the surface of the alluvial aquifer indicate that most of the contaminants were detected in the top 15 to 20 feet of soil.

A baseline risk assessment should be conducted to develop soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants at this site will be assessed to determine if remediation is required.

#### **7.1.8 1,2-Dichloroethane Source Area**

As depicted in Figure 5-23, the suspected source area has been delineated both horizontally and vertically in soil. Analytical data from the source area soil samples indicate two potential sources. The most heavily impacted area is southwest of Unit 4 and northeast of well EMW-7, which also is most heavily contaminated with 1,2-dichloroethane (84,000 ppb). The 1,2-dichloroethane concentrations were highest at approximately 30 feet bgs, near the surface of the alluvial clay aquitard. Surficial soil exhibited relatively low concentrations, or were nondetect. This suggests that the contaminant release occurred some time ago, allowing the 1,2-dichloroethane to percolate through the upper soil and collect on the surface of the clay semi-confining unit. The lower concentrations detected in shallow soil most likely result from residual contamination adsorbed to the sediment. Furthermore, the absence, or relatively low concentrations, of 1,2-dichloroethane in surficial soils may indicate that the release did not occur on the ground surface. Both of these assumptions, and the shape of the delineated source area, support the theory that the former tile wastewater line is the primary source of 1,2-dichloroethane in soil and groundwater.

The extent of the impacted area has been sufficiently defined; therefore, no additional investigative sampling is necessary. A baseline risk assessment should be conducted to develop



soil cleanup criteria. After cleanup levels are established, the extent of soil contaminants at this site will be assessed to determine if remediation is required.

## **7.2 Groundwater**

Two water-bearing units were identified on the Cedar Chemical facility. A perched water-bearing zone was detected above the clay aquitard, which lies approximately 10 to 20 feet bgs. This perched zone appears to be associated with areas where large amounts of fill material have been placed at the surface or a water recharge source, such as the treatment ponds, is available. This perched zone is not continuous across the site and static water levels within this zone fluctuate with rainfall and seasonal changes.

The alluvial aquifer at the site is a confined, water-bearing zone beginning below the clay aquitard at approximately 30 to 40 bgs and extending to the stiff clay and lignite which compose the Jackson-Claiborne Group at approximately 150 bgs. The alluvial aquifer is continuous across the site and is capable of producing large volumes of water, as is evidenced by the lithologies encountered and the presence of the high-production agricultural irrigation wells screened in the alluvial aquifer near the site. Potentiometric surface maps of the alluvial aquifer indicate a general flow to the south-southwest.

The most notable groundwater contamination present onsite was detected in the alluvial aquifer. While several contaminants were detected in various wells at the site, groundwater contamination is best defined by two contaminants, 1,2 dichloroethane and Dinoseb. These contaminants were detected consistently across the site and their associated contaminant plumes encompass virtually all other significant contamination.

1,2 Dichloroethane is a chlorinated solvent primarily associated with chemical formulations used in various industrial processes. As noted in Section 6, the 1,2-dichloroethane plume extends from the center of the process area on the north side of the site to the wastewater treatment



ponds to the south. The plume extends beyond the property boundaries to the east and southeast, but appears to be contained within the site boundaries to the west and southwest. Cedar Chemical was unable to obtain access to property north of the site to determine the actual northern boundary of the plume. The depth of the plume appears to extend to the bottom of the alluvial aquifer, approximately 150 feet bgs.

Based upon the orientation of the concentration gradients of the plume, there appear to be at least two source areas for the 1,2-dichloroethane. Contamination detected south of the facility across Industrial Park Road suggests that the wastewater treatment ponds were once a source of groundwater contamination. The other source area, which has not been specifically identified, appears to be near the production units on the northeast side of the plant.

Offsite plume-chasing conducted during Phase III consisted of the sampling of 16 locations with a Geoprobe water sampler to determine horizontal and vertical extents of VOCs in the aquifer. Screening samples indicated that a dissolved plume extends approximately 0.9 miles offsite to a maximum depth of 110 feet. However, 1,2-dichloroethane was detected in shallow offsite monitoring well OFFMW-2, indicating that the lateral extent has not been completely defined.

Dinoseb, which was produced at the site in the early 1970s, was detected above PQL in four wells and one hydropunch boring. As discussed in Section 6, the Dinoseb plume extends from the center of the production units, near Site 4, to the former Dinoseb disposal ponds at Site 9. Dinoseb contamination was detected as deep as 80 feet bgs. While the former disposal ponds may be contributing to the Dinoseb plume, no upgradient source has been identified. The concentration gradient indicates a primary source area upgradient of the former ponds in the vicinity of Site 4.

A baseline risk assessment will be conducted to determine groundwater cleanup levels and assess the extent of contamination. Remedial alternatives for groundwater will be addressed in a Corrective Measures Study (CMS).